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Utility of Psychomotor Tests for Prediction of Navy Enlisted Performance

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2. One class of tests that might be considered for development are ones that measure psychomotor abilities. Tests of psychomotor ability have proved useful in pilot selection and some civilian jobs. The present report is a literature review of various types of psychomotor tests, their reliabilities and predictive validities. It will provide assistance in determining whether tests of psychomotor ability should be added to the ASVAB.

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Utility of Psychomotor Tests for Prediction of Navy Enlisted Performance

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The psychomotor ability literature was reviewed to evaluate the usefulness of several types of psychomotor tests for personnel selection. Over 2,000 psychomotor test validity coefficients were identified and then organized according to type of psychomotor ability and criterion type (job vs. training vs. other). The results showed that psychomotor tests have been used successfully to predict job and training performance for many occupations. Psychomotor tests typically have high test-retest and internal consistency reliabilities. Data on practice effects showed that there are considerable gains in test scores over trials. Correlations between psychomotor and cognitive ability tests were generally low. Promising tests of various psychomotor abilities were also identified. Overall, the results suggest that certain types of psychomotor tests may be useful for personnel selection and classification.

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SUMMARY

Problem

The Navy Personnel Research and Development Center is interested in determining whether psychomotor tests might improve the prediction of Navy enlisted performance, and if so, which ratings and types of psychomotor tests are candidates for future research.

Purposes

The objectives of this report are to (1) define psychomotor ability, (2) describe the types of psychomotor abilities, and (3) review the usefulness of existing tests of these psychomotor abilities.

Approach

A review of the military and civilian psychomotor test literature was undertaken to determine the usefulness of psychomotor tests for personnel selection and classification. Over 100 articles, technical reports, papers and test manuals were reviewed.

Results and Discussion

Nine psychomotor abilities were identified. Several of these abilities (multilimb coordination, finger dexterity, manual dexterity, wrist-finger speed, control precision) were shown to predict job and training criteria. Other results indicated that psychomotor tests generally have high reliability, low correlations with cognitive ability measures, and large practice effects. Tests measuring promising psychomotor abilities were described and discussed.

Recommendations

The results of this literature review suggest that several types of psychomotor ability should be examined as possible predictors of Navy enlisted performance.

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SECTION 1. OVERVIEW AND DESCRIPTION OF PSYCHOMOTOR ABILITY

Overview of Report

The purposes of this report are to identify the types of abilities represented in the psychomotor domain and to evaluate the usefulness of psychomotor tests for personnel selection and classification. The results of this report are organized into three sections. This section begins with a brief overview of psychomotor research. The concept of psychomotor ability is then defined and several taxonomies of psychomotor ability are described. A final taxonomy is then presented around which the rest of this report is organized.

Section Two reviews selected measures of each psychomotor ability. Information regarding the validity, reliability, practice effects, and correlations with cognitive abilities for these tests is presented and recommendations are made regarding the best measures of each psychomotor ability. The section concludes with a discussion of several issues relevant to psychomotor testing.

Section Three summarizes the major findings of this report and identifies those psychomotor abilities and tests most likely to be useful in Navy selection and classification.

Brief Overview of Psychomotor Research

Much of the research in psychomotor assessment has involved the prediction of aircrew performance in military settings. Early psychomotor investigations in military pilot selection relied primarily on paper-and-pencil measures (cf. Guilford and Lacey, 1947). During World War II, however, emphasis shifted to developing apparatus measures of psychomotor ability. Several of these apparatus tests were found to be relatively good predictors of aircrew performance.

With the end of World War II, efforts to develop new apparatus measures waned as the need for pilots decreased. During this time, several researchers investigated the underlying structure of these military pilot test batteries (e.g., Guilford and Lacey, 1947; Dudek, 1948; Michael, 1949). Much of this research was summarized by Fleishman (1953), who identified 10 psychomotor ability factors as worthy of future investigation.

During the 1950s and early 1960s, Fleishman and his colleagues conducted a series of factor analytic studies to identify the basic psychomotor abilities in pilot performance. This research included over 200 psychomotor tests and resulted in the identification of eleven psychomotor abilities. Ironically, it was during this time that the Air Force discontinued use of psychomotor apparatus tests for aircrew personnel because of the problems associated with these tests (e.g., equipment unreliability, test development costs, and administrative costs). This led to renewed research on less complex apparatus and paper-and-pencil measures of psychomotor abilities. The results of these efforts were disappointing, however, leading Cronbach (1970) to conclude that it was unlikely that complex dexterity and coordination abilities could be measured using either paper-and-pencil tests or simple motor tests. Other reviewers of the psychomotor

literature (e.g., Passey and McLaurin, 1966; North and Griffin, 1977; Imhoff and Levine, 1981) advocated renewed use of apparatus measures.

Use of computers for psychomotor assessment marked the beginning of the current phase of psychomotor measurement. Sanders, Valentine, and McGrevy, (1971) developed two computerized measures of multilimb coordination and found encouraging results. However, these early computer tests were expensive to develop and administer, and as a result, relatively little additional research on computerized psychomotor measures took place during the 1970's. Recent advances in computer technology have created a renewed interest in psychomotor testing. New microcomputer-based psychomotor tests have shown promising results in large scale studies involving Army soldiers (e.g., Peterson, Hough, Dunnette, Rosse, Houston, Toquam, and Wing, 1987).

Definition of Psychomotor Abilities

Psychomotor abilities refer to abilities that involve the execution of motor responses such as manipulative, repetitive, and precise limb movements (Imhoff and Levine, 1981). These include such abilities as finger dexterity, manual dexterity, multilimb coordination, and speed of arm movement. The distinguishing characteristic of all psychomotor abilities is that they involve motor movement.

Psychomotor abilities are closely related to perceptual abilities. Because psychomotor responses depend on the perception and processing of stimulus information, the distinction between perceptual and psychomotor abilities is somewhat arbitrary. Imhoff and Levine (1981) suggested that perceptual abilities refer to the perception and processing of stimulus or sensory information. These include such abilities as perceptual speed, spatial visualization, and flexibility and speed of closure. In contrast, psychomotor abilities emphasize the response, rather than the stimulus, aspects of the situation.

Psychomotor abilities should also be differentiated from physical abilities. Fleishman (1964) suggested that physical abilities relate to gross physical proficiency or fitness. These include such abilities as static and dynamic strength, extent and dynamic flexibility, body coordination, body balance, and stamina. In contrast, psychomotor abilities refer to more refined motor movements that do not involve the use of large muscles of the body.

Taxonomies of Psychomotor Ability

In this section several taxonomies that include psychomotor abilities are reviewed. The section concludes with a final taxonomy that is used to organize the the rest of this report.

Fleishman's Psychomotor Taxonomy

The most systematic research directed toward defining the psychomotor domain was conducted by Fleishman and his colleagues. During the 1950s and early 1960s, Fleishman performed a series of factor analytic studies with military airmen to identify the basic structure of the psychomotor domain (Fleishman, 1954; Fleishman and Hempel, 1954; Hempel and Fleishman, 1955;

Fleishman and Hempel, 1955; Fleishman and Hempel, 1956; Fleishman, 1958; Parker and Fleishman, 1960; Fleishman and Ellison, 1962). The method used in several of these studies involved administering a battery of psychomotor tests (apparatus and paper-and-pencil) to a sample of military airmen or airmen trainees. In some studies, perceptual, physical, or cognitive ability tests were also included in the test battery. Pearson product-moment correlations were then computed among the test scores and the resulting intercorrelation matrix factor analyzed (generally using Thurstone's Centroid procedure) and rotated orthogonally to simple structure.

Based on factor analyses of over 200 tests, Fleishman (1964) identified eleven psychomotor abilities. All of these abilities had been found in at least two factor analytic studies and most were found in four or more studies. These abilities and their definitions (taken from Fleishman, 1967, pp. 352-353) are shown in Table 1.

Nine of the 11 abilities described in Table 1 (aiming, arm-hand steadiness, control precision, finger dexterity, manual dexterity, multilimb coordination, rate control, speed of arm movement, and wrist-finger speed) are relevant to the present review. Two of these abilities, reaction time and response orientation, are not relevant. Reaction time was specifically excluded in the Statement of Work for this project. Response orientation involves the <u>selection</u> of the appropriate response to a stimulus from two or more alternatives under highly speeded conditions (e.g., visual discrimination reaction tasks). Since this ability involves cognitive-perceptual abilities and relatively little motor skill (e.g., lifting a finger from a button), it is not included in this review.

It should be noted that Fleishman's taxonomy of psychomotor abilities has not gone unchallenged. For example, Jones (1960, 1962) suggested that a deductive, theory-testing approach is more appropriate than factor analysis for identifying basic psychomotor abilities.

<u>Siegel, Federman, and Welsand's Perceptual/Psychomotor Taxonomy</u>

Siegel, Federman, and Welsand (1980) reviewed several taxonomies that included either perceptual or psychomotor abilities as part of a study to identify the types of perceptual-motor abilities required in 35 Air Force career fields. They developed a preliminary list of perceptual-psychomotor abilities from the following sources:

- Fleishman's (1964) taxonomy of 19 psychomotor and physical abilities

- Harrow's (1972) perceptual and psychomotor categories for describing childrens' movement behavior

- Hunter's (1975) taxonomy of 11 ability factors underlying performance on 28 perceptual/psychomotor and paper-and-pencil tests

- Rarick and Dobbin's (1975) taxonomy of 4 ability factors underlying performance on several psychomotor/physical measures for children

Table 1

Psychomotor Abilities Identified by Fleishman (1967)

1. Control Precision: This factor is common to tasks that require fine, highly controlled, but not overcontrolled muscular adjustments, primarily where larger muscular groups are involved. This ability extends to arm-hand as well as to leg movements. It is most critical where such adjustments must be rapid, but precise.

2. Multilimb Coordination: This is the ability to coordinate the movements of a number of limbs simultaneously, and is best measured by devices involving multiple controls. The factor has been found general to tasks requiring coordination of two feet, two hands, and hands and feet.

3. Response Orientation: This ability factor has been found general to visual discrimination reaction psychomotor tasks involving rapid directional discrimination and orientation of movement patterns. It appears to involve the ability to select the correct movement in relation to the correct stimulus, especially under highly speeded conditions.

4. Reaction Time: This represents simply the speed with which the individual is able to respond to a stimulus when it appears. Individual differences in this ability are independent of whether the stimulus is auditory or visual and are also independent of the type of response which is required. However, once the stimulus situation or the response situation is complicated to involve alternate choices, reaction time is not the primary factor that is measured.

5. Speed of Arm Movement: This represents simply the speed with which an individual can make a gross, discrete arm movement where accuracy is not the requirement.

6. Rate Control: This ability involves the timing of continuous anticipatory motor adjustments relative to changes in speed and direction of a continuously moving target or object. This factor is general to tasks involving compensatory as well as following pursuit, and extends to tasks involving responses to changes in rate.

7. Manual Dexterity: This ability involves skillful, well-directed arm-hand movements in manipulating fairly large objects under speed conditions.

Table 1 (cont.)

8. Finger Dexterity: This is the ability to make skillful, controlled manipulations of tiny objects involving, primarily, the fingers.

9. Arm-hand Steadiness: This is the ability to make precise arm-hand positioning movements where strength and speed are minimized; the critical feature, as the name implies, is the steadiness with which such movements can be made. The ability extends to tasks in which a steady arm or hand position is to be maintained.

10. Wrist-Finger Speed: This ability has been called "tapping" in many previous studies. This factor is highly restricted in scope and does not extend to many tasks in which apparatus is used. It has been found that the factor is best measured by printed tests required rapid tapping of the pencil in relatively large areas.

11. Aiming: This ability appears to be measured by printed tests which provide the subject with very small circles to be dotted in, whether there are a large number of circles and when the test is highly speeded. The subject typically goes from circle to circle placing one dot in each circle as rapidly as possible. This factor has not been found to extend to apparatus tests.

- Pfeiffer, Siegel, Taylor, and Shuler's (1978) taxonomy of 7 perceptual/psychomotor abilities underlying military tasks

- several perceptual/psychomotor abilities measured by published test batteries (General Aptitude Test Battery, Differential Aptitude Test, Flanagan Aptitude Classification Tests, Employee Aptitude Survey, Guilford-Zimmerman Aptitude Survey); and,

- 17 perceptual/psychomotor abilities relevant to Air Force specialties (Siegel et al., 1980).

This initial list of abilities was then reduced by combining abilities that were redundant or related, eliminating abilities that were not related to perceptual/psychomotor ability, and deleting abilities that were least compatible with and applicable to various Air Force jobs. The result was a list containing 13 perceptual-motor abilities, five of which are primarily psychomotor in nature. These five psychomotor abilities and their definitions (taken from Siegel et al., 1980, pp. 26, 29) are presented below:

1. Control Precison: the ability to perform rapid, precise, fine controlled adjustments by either arm and hand movements or leg movements

2. Manual Dexterity: the ability to perform skillful, well-directed arm and hand movements to manipulate either fairly large or fairly small objects under speeded conditions

3. Finger Dexterity: the ability to perform skillful manipulations of small objects with the fingers

4. Multilimb Coordination: the ability to coordinate the movements of a number of limbs simultaneously, e.g., two hands, two feet, and hands and feet together

5. Rate Control (Tracking): the ability to perform continuous anticipatory motor adjustments relative to changes in speed and direction of a continuously moving object

The eight perception-oriented abilities were visual speed and accuracy, visual memory, position memory, auditory discrimination, auditory memory, clerical perception, perception of size and form, and depth perception.

Imhoff and Levine's Taxonomy

Imhoff and Levine (1981) reviewed the perceptual/psychomotor and cognitive literature relevant to pilot training and selection. They hypothesized that: (1) two perceptual-motor dimensions--basic movement speed and accuracy and perceptual-motor movement control--are most critical for pilot research; and (2) many of Fleishman's psychomotor abilities can be collapsed into these two dimensions.

The basic movement speed and accuracy dimension refers to the speed and accuracy with which a movement can be made. These movements tend to be

highly structured, and once inititated, require minimal processing or feedback to be carried out. Imhoff and Levine suggested that this dimension subsumes three psychomotor abilities identified by Fleishman: control precision, reaction time, and speed of arm movement.

The perceptual-motor movement control dimension refers to movements that are directed by sensory and perceptual feedback after the initial responses. This dimension involves movements in which the use of feedback and sensory cues guide later movements. Imhoff and Levine suggested that this dimension includes Fleishman's multilimb coordination, response orientation, and rate control abilities.

McHenry's Taxonomy

McHenry (1987) proposed an extension of the Imhoff and Levine (1981) taxonomy to include three other psychomotor abilities identified by Fleishman. This hierarchical taxonomy has three levels of psychomotor ability. At the most general level is the construct of psychomotor ability. This construct can be broken down into three second-level psychomotor abilities: basic movement speed and accuracy, perceptual-motor movement control, and dexterity. Each second-level ability subsumes two or more specific psychomotor abilities identified by Fleishman. Basic movement speed and accuracy subsumes control precision, speed or arm movement, wrist-finger speed, and aiming. Perceptual-motor movement control subsumes rate control, multilimb coordination, and arm-hand steadiness. Finally, dexterity ability subsumes manual and finger dexterity.

A Final Psychomotor Taxonomy

Of the taxonomies reviewed, the taxonomy presented by Fleishman (1964, 1967) is probably the most relevant to the current Navy research program. This taxonomy has the most research support and includes the greatest number of abilities of the taxonomies reviewed. The taxonomies presented by Siegel et al. (1980) and Imhoff and Levine (1981) do not include several abilities identified by Fleishman. The Siegel et al. (1980) taxonomy does not include speed of arm movement, arm-hand steadiness, wrist-finger speed, and aiming. The Imhoff and Levine (1981) taxonomy omits manual dexterity, finger dexterity, arm-hand steadiness, aiming and wrist-finger speed. Although both Imhoff and Levine (1981) and McHenry (1987) provide a possible explication of the second-order dimensions underlying Fleishman's psychomotor abilities, no empirical evidence is presented supporting the utility of their hierarchical taxonomies. More importantly, their second order factors are probably too broad to distinguish meaningfully between Navy ratings with respect to psychomotor ability. The level of specificity of Fleishman's abilities would appear to correspond more closely to the goals of the current research program. The nine relevant abilities are sufficiently general to be useful for a range of military jobs (cf. Melton, 1947), yet specific enough to enable the development of relatively homogeneous ability measures.

SECTION 2. EVALUATION OF SELECTED PSYCHOMOTOR TESTS

In this section, measures of the nine psychomotor abilities identified in Section One are reviewed. These measures are reviewed according to their validity, reliability, practice effects, and correlations with cognitive abilities. A summary of these results across all tests is then presented. The section concludes with a discussion of several issues related to psychomotor testing: use of complex psychomotor tests, differential stability, and test format.

Test Search Procedure

A review of the psychomotor literature was undertaken to identify measures of the nine abilities identified in Section One (aiming, arm hand steadiness, control precision, finger dexterity, manual dexterity, multilimb coordination, rate control, speed of arm movement, wrist-finger speed). These search activities included: (1) conducting several computerized searches using the PSYCINFO data base; (2) checking reference sections of relevant articles and reports; (3) contacting researchers active in the psychomotor testing; and, (4) checking the last several years' editions of selected research journals (e.g., Perceptual and Motor Skills, Journal of Motor Behavior), as well as textbooks and handbooks. Overall, almost 200 articles, technical reports, papers, and test manuals were reviewed.

Test Characteristics Studied

These sources were examined for information about the characteristics (e.g., validity, reliability, etc.) of various psychomotor tests. Several characteristics were reviewed. First, studies of the criterion-related validity of each predictor were reviewed. Validity results were gathered for three types of criteria: job performance (e.g., supervisor ratings, job proficiency measures, work sample measures), training performance (e.g., graduation/elimination from training, training exam scores, training instructor evaluations), and "other" miscellaneous criteria (e.g., school course grades, instructor ratings).

Reliability information for each psychomotor test was also reviewed. Of primary interest was the test-retest reliability of each predictor, although other types of reliability indices (e.g., corrected split-half correlations, internal consistency reliability indices) were also collected.

Data on the correlations of each test with various cognitive abilities were also gathered. The cognitive ability categories used correspond to the abilities measured by the Armed Services Vocational Aptitude Battery (ASVAB) subtests. These categories are perceptual speed and accuracy, spatial ability, mechanical aptitude, verbal ability, numerical aptitude, reasoning ability, science knowledge, electronics knowledge, and automobile/shop/tool knowledge.

Finally, information was sought regarding the practice effects for each test. To assess practice effects, gain scores (Cronbach and Furby, 1970) were computed.

Complete information regarding validity results, reliability results, practice effects, and intercorrelations with cognitive tests was not available for most of these psychomotor tests. Thus, several measures having only partial test information are included in the test summary tables. At a minimum, however, a predictor was required to have validity information to be included in the summary tables.

Evaluations of Selected Psychomotor Tests

Most of the psychomotor tests located had little or no test information. Of those included, approximately 50 having validity information were reviewed for this report. These tests are listed in Table 2 according to the psychomotor ability measured. Brief descriptions of these tests are given in Appendix A.

Table 3 presents a summary of validity results, reliability results, and practice effects for each psychomotor test. The table is organized according to the psychomotor ability measured. Table 4 presents a summary of the correlations of each psychomotor test with various cognitive abilities. This table is also organized by psychomotor construct. Detailed information about the validity results, reliability results, practice effects, and correlations with cognitive abilities for each of these tests is presented in a series of appendices. Appendix B shows summaries of individual validity studies for each psychomotor test, organized by psychomotor construct. Appendix C presents summaries of the individual reliability studies for each psychomotor test, organized by psychomotor construct. Appendix D presents summaries of the mean test scores and standard deviations across trials for these tests. Finally, Appendix E presents summaries of the correlations between each psychomotor test and various cognitive abilities.

Aiming

A summary of validity results, reliability results, and practice effects for tests measuring aiming ability is shown in Table 3. All seven aiming measures are paper-and-pencil tests (see Appendix A for brief descriptions of these tests).

The median validities of these aiming measures are generally low. Only one test, the FACT-Precision, has a mean validity of .15 or greater across criteria. All the other aiming tests have validities that are less than .10.

Reliability information was located for only four aiming tests. The FACT-Coordination has a test-retest reliability of .65. Corrected split-half reliability coefficients for the Small Tapping Test, Tracing test, and FACT-Precision range from .80 to .89.

None of these aiming tests reported practice information in the studies reviewed.

Table 2

Selected Measures of Psychomotor Abilities

Aiming

Crossing Test (Mullins et al., 1968)[a]
Flanagan Aptitude Classification Test - Coordination (Flanagan, 1959)
Flanagan Aptitude Classification Test - Precision (Flanagan, 1959)
Small Tapping Test (Fleishman and Hempel, 1954)
Trace Tapping I (Mullins et al., 1968)
Trace Tapping II (Mullins et al., 1968)
Tracing (Mullins et al., 1968)

Arm-Hand Steadiness

Arm-Hand Steadiness Test (Melton, 1947)
Line Control (Mullins et al., 1968)
Steadiness Aiming Test (Melton, 1947)

Control Precision

Dial Setting Test (Melton, 1947)
Pursuit Confusion Test (Fleishman, 1956)
Rotary Pursuit Test (Melton, 1947)
Target Tracking Test 1 (McHenry, 1987)

Finger Dexterity

Crawford Small Parts Dexterity Test (Grant and Bray, 1970)
General Aptitude Test Battery - Finger Dexterity (U.S. Dept. of Labor, 1970)
O'Connor Finger Dexterity Test (Rim, 1962)
Pinboard Test (Farr et al., 1971)
Purdue Pegboard (Rim, 1962)
Santa Ana Finger Dexterity Test (Melton, 1947)

Manual Dexterity

Formboard Test (Farr et al., 1971)
General Aptitude Test Battery - Manual Dexterity (U.S. Dept. of Labor, 1970)
Hand Tool Dexterity Test (Bennett and Fear, 1943)
Minnesota Rate of Manipulation Test (Rim, 1962)
Pennsylvania Bi-Manual Work Sample (Rim, 1962)
Peg Placing (Mathews and Jensen, 1977)
Peg Turning (Mathews and Jensen, 1977)
Stromberg Dexterity Test (Rim, 1962)

Table 2 (cont.)

Multilimb Coordination

Bi-Manual Coordination Test (Melton, 1947)
Complex Coordination Test (Melton, 1947)
Complex Coordination Test (Sanders et al., 1971)
Rudder Control Test (Melton, 1947)
Target Tracking Test 2 (McHenry, 1987)
Two-Hand Coordination Test (Melton, 1947)
Two-Hand Coordination Test (Sanders et al., 1971)
Two-Hand Pursuit Test (Melton, 1947)

Rate Control

Motor Judgment Test (Farr et al., 1971)
Rate Control (Melton, 1947)
Single-Dimension Pursuitmeter (Melton, 1947)
Target Shoot Test (McHenry, 1987)

Speed of Arm Movement

Two-Plate Tapping Test (Melton, 1947)

Wrist-Finger Speed

Employee Aptitude Survey-Manual Speed and Accuracy (Psychological Services, 1957)
General Aptitude Test Battery - Motor Coordination (U.S. Dept. of Labor, 1970)
Hand Skills Test (Cory et al., 1980)
Large Tapping Test (Fleishman, 1954)
Manual Speed (Cory et al., 1980)
Mark Making Test (Mathews and Jensen, 1977)

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[a]The references provided simply represent one article or report in which the test was used or described. Many of these tests have been used and described in more than one article or report.

Table 3

Summary of Validity Results, Reliability Results, and Practice Effects for Selected Measures of Nine Psychomotor Abilities

Construct Aiming

Test	Validity Results[a]			Reliability Results[b]			Gain Score Over Trial 1[c]						
	Criterion												
	Job	Trg	Other	Test-Retest	Corrected Split-Half	Other	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
Trace Tapping II	—	.01[d] (4)	—	—	—	—	—	—	—	—	—	—	—
Small Tapping Test	—	-.07 (2)	—	—	.89[e] (1)	—	—	—	—	—	—	—	—
Crossing Test	—	-.09 (2)	—	—	—	—	—	—	—	—	—	—	—
Tracing	—	.00 (2)	—	—	.85 (1)	—	—	—	—	—	—	—	—
Trace Tapping I	—	-.02 (2)	—	—	—	—	—	—	—	—	—	—	—
FACT Precision	.36 (3)	—	.12 (11)	—	.83 (1)	.80 (2)	—	—	—	—	—	—	—
FACT Coordination	.07 (15)	—	.06 (1)	.65 (1)	.86 (1)	.86 (2)	—	—	—	—	—	—	—

Construct Arm Hand Steadiness

Test	Job	Trg	Other	Test-Retest	Corrected Split-Half	Other	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
Arm Hand Steadiness Test	—	.06 (13)	—	.75 (1)	.90 (1)	.76 (1)	—	—	—	—	—	—	—

Construct Arm Hand Steadiness (Continued)

Test	Validity Results[a]			Reliability Results[b]			Gain Score Over Trial 1[c]						
	Criterion												
	Job	Trg	Other	Test-Retest	Corrected Split-Half	Other	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
Steadiness Aiming Test	—	.13 (1)	—	—	—	.91 (2)	—	—	—	—	—	—	—
Line Control	—	-.10 (2)	—	—	—	—	—	—	—	—	—	—	—

Construct Control Precision

Test	Job	Trg	Other	Test-Retest	Corrected Split-Half	Other	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
Rotary Pursuit Test	—	.14 (27)	—	.88 (1)	.90 (2)	—	+90.2	+143.0	—	—	—	—	—
Pursuit Confusion Test	—	.30 (1)	—	—	.83 (2)	.89 (2)	—	—	—	—	—	—	—
Dial Setting Test	—	.25 (2)	—	—	.73 (2)	—	+58.8	+120.0	+128.8	—	—	—	—
Target Tracking Test 1	—	.55 (1)	—	.71 (2)	.98 (1)	.97 (1)	+8.3	—	—	—	—	—	—

Construct Finger Dexterity

Test	Job	Trg	Other	Test-Retest	Corrected Split-Half	Other	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
Santa Ana Finger Dexterity Test	-.05 (2)	.08 (41)	—	.78 (3)	.92 (2)	—	+110.3	+130.3	+142.9	+160.4	+167.9	+180.5	+190.5
Purdue Pegboard	.30 (14)	—	.70 (1)	.68 (7)	.83 (3)	.90 (1)	—	—	—	—	—	—	—

Construct Finger Dexterity (Continued)

Test	Validity Results[a]			Reliability Results[b]			Gain Score Over Trial 1[c]						
	Criterion												
	Job	Trg	Other	Test-Retest	Corrected Split-Half	Other	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
O'Connor Finger Dexterity Test	.04 (16)	.28 (1)	—	.87 (4)	.92 (4)	.76 (1)	—	—	—	—	—	—	—
GATB - Finger Dexterity	—	—	.20[f] (562)	.71 (4)	—	—	—	—	—	—	—	—	—
Crawford Small Parts Dexterity Test	.28 (14)	.37 (4)	.29 (1)	—	.89 (8)	.90 (2)	—	—	—	—	—	—	—
Pinboard Test	.15 (1)	.02 (1)	—	—	—	—	—	—	—	—	—	—	—

Construct Manual Dexterity

Test	Job	Trg	Other	Test-Retest	Corrected Split-Half	Other	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
Minnesota Rate of Manipulation Test	.21 (9)	—	.46 (3)	—	—	.89 (6)	—	—	—	—	—	—	—
GATB - Manual Dexterity	—	—	.20[f] (561)	.75 (4)	—	—	—	—	—	—	—	—	—
Stromberg Dexterity Test	—	—	.29 (1)	—	—	.84 (1)	—	—	—	—	—	—	—
Hand Tool Dexterity Test	.29 (9)	.34 (2)	.32 (1)	.87 (3)	—	.87 (1)	—	—	—	—	—	—	—
Pennsylvania Bi-Manual Work Sample	—	—	.10 (1)	—	.90 (1)	—	—	—	—	—	—	—	—
Formboard Test	.02 (1)	.00 (1)	—	—	—	—	—	—	—	—	—	—	—

Construct Manual Dexterity (Continued)

Test	Validity Results[a]			Reliability Results[b]			Gain Score Over Trial 1[c]						
	Criterion												
	Job	Trg	Other	Test-Retest	Corrected Split-Half	Other	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
Peg Turning	—	.07 (2)	—	—	—	—	—	—	—	—	—	—	—
Peg Placing	—	-.06 (2)	—	—	—	—	—	—	—	—	—	—	—

Construct Multilimb Coordination

Test	Job	Trg	Other	Test-Retest	Corrected Split-Half	Other	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
Two-Hand Pursuit Test	.43 (3)	.26 (11)	—	—	.83 (1)	.90 (1)	—	—	—	—	—	—	—
Two-Hand Coordination Test (Melton, 1947)	.15 (10)	.28 (54)	—	.83 (3)	.85 (2)	—	+43.3	+88.9	+70.7	+94.2	+104.3	+137.8	+110.5
Two-Hand Coordination Test (Sanders et al., 1971)	—	.15 (2)	—	—	—	.81 (1)	—	—	—	—	—	—	—
Rudder Control Test	—	.26 (29)	—	.72 (2)	.88 (2)	—	+37.7	+66.3	+63.8	+76.2	+75.3	—	—
Complex Coordination Test (Melton, 1947)	.16 (3)	.29 (57)	—	—	—	.92 (1)	+98.5	+148.3	+164.2	+183.8		—	—
Complex Coordination Test (Sanders et al., 1971)	—	.19 (4)	—	—	.95 (1)	—	—	—	—	—	—	—	—
Bi-Manual Coordination Test	—	.22 (3)	—	.76 (3)	.86 (2)	—	—	—	—	—	—	—	—
Target Tracking Test 2	—	.51 (1)	—	.81 (2)	.98 (1)	.97 (1)	-12.8	—	—	—	—	—	—

Construct Rate Control

Test	Validity Results[a]			Reliability Results[b]			Gain Score Over Trial 1[c]						
	Criterion												
	Job	Trg	Other	Test-Retest	Corrected Split-Half	Other	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
Rate Control	—	.02 (1)	—	—	.75 (2)	—	—	—	—	—	—	—	—
Single Dimension Pursuitmeter	—	.10 (2)	—	—	.85 (3)	—	—	—	—	—	—	—	—
Motor Judgment Test	-.02 (1)	—	—	—	.80 (4)	—	—	—	—	—	—	—	—
Target Shoot Test	—	.27 (1)	—	.50 (4)	.80 (2)	.85 (1)	+5.5	—	—	—	—	—	—

Construct Speed of Arm Movement

Test	Job	Trg	Other	Test-Retest	Corrected Split-Half	Other	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
Two-Plate Tapping Test	—	.07 (1)	—	.91 (1)	—	.98 (2)	+31.5	+51.8	+83.3	+107.5	+122.9	+131.3	+131.3

Construct Wrist-Finger Speed

Test	Job	Trg	Other	Test-Retest	Corrected Split-Half	Other	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
GATB - Motor Coordination	—	—	21[f] (556)	.85 (4)	—	—	—	—	—	—	—	—	—
EAS - Manual Speed and Accuracy	.30 (2)	—	.15 (6)	.77 (2)	—	—	—	—	—	—	—	—	—
Large Tapping Test	—	.04 (2)	—	—	.94 (1)	—	—	—	—	—	—	—	—

Construct Wrist-Finger Speed (Continued)

Test	Validity Results[a]			Reliability Results[b]			Gain Score Over Trial 1[c]						
	Criterion												
	Job	Trg	Other	Test-Retest	Corrected Split-Half	Other	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
Mark Making Test	—	-.05 (2)	—	—	—	—	—	—	—	—	—	—	—
Manual Speed	.14 (1)	—	—	.57 (1)	—	—	—	—	—	—	—	—	—
Hand Skills Test	.20 (1)	—	—	.68 (1)	—	—	—	—	—	—	—	—	—

[a] Trg = Training Criteria; Other = Educational or other criterion measures

[b] Other = Internal consistency or other reliability measures.

[c] Gain score was computed using the following formula:

$$\frac{\text{Mean Score Trial X} - \text{Mean Score Trial 1}}{\text{Standard Deviation Trial 1}}$$

[d] The top entry in each cell of the validity results section is the median correlation between the psychomotor predictor and criterion type. The bottom entry is the number of correlations located for this test-criterion type combination.

[e] The top entry in each cell of the reliability results section is the mean reliability coefficient for this test and reliability assessment method. The bottom entry is the number of correlations located for this test-reliability method combination.

[f] Includes validity studies using job, training, and education criteria.

Table 4

Mean Correlations Between Selected Measures of Nine Psychomotor Constructs and Various Cognitive Abilities

Construct Aiming

Psychomotor Test	Cognitive Ability								
	Perceptual Speed and Accuracy	Spatial Ability	Mechanical Aptitude	Verbal Ability	Numerical Aptitude	Reasoning	Science Knowledge	Electronics Knowledge	Auto/Shop Tool Knowledge
Trace Tapping II	—	—	—	—	—	—	—	—	—
Small Tapping Test	—	—	—	—	—	—	—	—	—
Crossing Test	—	—	—	—	—	—	—	—	—
Tracing	—	—	—	—	—	—	—	—	—
Trace Tapping I	—	—	—	—	—	—	—	—	—
FACT Precision	.33	.21	.13	.23	.22	.21	—	—	—
FACT - Coordination	.26	.19	.10	.17	.17	.15	—	—	—

Construct Arm-Hand Steadiness

Arm-Hand Steadiness Test	.06	.04	.00	.01	.01	-.01	—	—	—
Steadiness Aiming Test	—	—	—	—	—	—	—	—	—
Line Control	—	—	—	—	—	—	—	—	—

Construct Control Precision

Rotary Pursuit Test	.14	.14	.22	.05	.03	.05	—	.11	—
Pursuit Confusion Test	—	—	—	—	—	—	—	—	—
Dial Setting Test	.22	.08	-.06	.14					
Target Tracking Test 1	.06	—	.41	.18	.23	.33	.25	.29	.35

Construct Finger Dexterity

Psychomotor Test	Cognitive Ability								
	Perceptual Speed and Accuracy	Spatial Ability	Mechanical Aptitude	Verbal Ability	Numerical Aptitude	Reasoning	Science Knowledge	Electronics Knowledge	Auto/Shop Tool Knowledge
Santa Ana Finger Dexterity Test	.17	.14	.10	.10	.05	.08	—	—	.15
Purdue Pegboard	.36	—	.19	.24	—	—	—	—	.46
O'Connor Finger Dexterity	—	-.16	-.11	—	—	.21	—	—	—
GATB - Finger Dexterity	.26	.26	.27	.14	.19	.19	—	—	—
Crawford Small Parts Dexterity Test	—	—	.27	.11	.17	.21	—	—	—
Pinboard Test	—	—	—	—	—	—	—	—	—

Construct Manual Dexterity

Minnesota Rate of Manipulation Test	—	—	—	—	—	—	—	—	—
GATB - Manual Dexterity Scale	.31	.18	.16	.09	.15	.10	—	—	—
Stromberg Dexterity Test	—	—	—	—	—	—	—	—	—
Hand-Tool Dexterity Test	—	.25	.13	—	.00	-.02	—	—	—
Pennsylvania Bi-Manual Work Sample	—	—	—	—	—	—	—	—	—
Formboard Test	—	—	—	—	—	—	—	—	—
Peg Turning	—	—	—	—	—	—	—	—	—
Peg Placing	—	—	—	—	—	—	—	—	—

Construct Multilimb Coordination

Two-Hand Pursuit Test	—	—	—	—	—	—	—	—	—

Construct Multilimb Coordination (Continued)

Psychomotor Test	Cognitive Ability								
	Perceptual Speed and Accuracy	Spatial Ability	Mechanical Aptitude	Verbal Ability	Numerical Aptitude	Reasoning	Science Knowledge	Electronics Knowledge	Auto/Shop Tool Knowledge
Two-Hand Coordination Test (Melton, 1947)	.13	.16	.36	.12	.05	.14	—	—	—
Two-Hand Coordination Test (Sanders et al., 1971)	—	—	-.15	.07	-.06	—	-.12	—	—
Rudder Control Test	.06	.09	.27	.00	-.05	.06	—	.13	—
Complex Coordination Test (Melton, 1947)	.13	.16	.36	.12	.05	.14	—	—	—
Complex Coordination Test (Sanders et al., 1971)	—	—	-.10	-.02	.06	—	.05	—	—
Bi-Manual Coordination Test	.21	.14	.00	.03	.02	—	—	—	—
Complex Coordination Test	.24	.26	.33	.17	.12	.17	—	.18	.33
Target Tracking Test 2	.01	—	.39	.16	.24	.30	.29	.31	.38

Construct Rate Control

Rate Control	—	—	—	—	—	—	—	—	—
Single Dimension Pursuit-meter	—	—	—	—	—	—	—	—	—
Motor Judgment Test	—	—	—	—	—	—	—	—	—
Target Shoot Test	.01	—	.22	.04	.12	.17	.13	.19	.20

Construct Speed of Arm Movement

Two-Plate Tapping Test	—	—	—	—	—	—	—	—	—

Construct Wrist-Finger Speed

Psychomotor Test	Cognitive Ability								
	Perceptual Speed and Accuracy	Spatial Ability	Mechanical Aptitude	Verbal Ability	Numerical Aptitude	Reasoning	Science Knowledge	Electronics Knowledge	Auto/Shop Tool Knowledge
GATB - Motor Coordination	.49	.17	—	.35	.35	.30	—	—	—
EAS - Manual Speed and Accuracy	—	—	—	—	—	—	—	—	—
Large Tapping Test	—	.02	.14	.11	—	.10	—	.14	.09
Mark Making Test	—	—	—	—	—	—	—	—	—
Manual Speed	—	—	—	—	—	—	—	—	—
Hand Skills Test	—	—	—	—	—	—	—	—	—

Table 4 summarizes the correlations of the FACT-Coordination and FACT-Precision with measures of various cognitive abilities. The results indicate that both tests have relatively low correlations with cognitive abilities.

Overall, relatively little information was found regarding the test characteristics of these aiming tests. Of the tests reviewed, the FACT-Precision appears to have the most promise from a selection standpoint. This is a speeded paper-and-pencil test that requires examinees to trace within the space between narrowly separated concentric circles or squares without touching the edges of the circles. The data for the FACT-Precision, however, are limited. Information regarding test-retest reliability and practice effects was not located.

Arm Hand Steadiness

The characteristics of three measures of arm hand steadiness are reviewed in Table 3. The validity results indicate that arm steadiness measures have low correlations with training criteria. All of these tests have median validity coefficients that are less than .15. The highest median validity (.13) is for the Steadiness Aiming Test and that is based on only one study. The Arm Hand Steadiness Test has 13 validity studies, but only one validity coefficient was greater than .15 (see Appendix B).

Reliability results were located for two of the three arm hand steadiness measures. The Arm Hand Steadiness Test has a test-retest reliability of .75. The Steadiness Aiming Test has a mean reliability of .91.

No information regarding practice effects was found for any of these arm hand steadiness tests.

Table 4 shows the correlations between the Arm-Hand Steadiness Test and various cognitive abilities. These correlations are consistently low, with all correlations being less than .07.

In summary, only three measures of arm-hand steadiness having validity results were found and none of these tests appears promising. The results suggest that arm hand steadiness has limited utility for predicting job or training performance.

Control Precision

Validity results for four measures of control precision are shown in Table 3. The results indicate that three of these four tests (Pursuit Confusion Test, Dial Setting Test, Target Tracking Test 1) have median validities of .25 or greater for training criteria. The validity of the Target Tracking Test 1 is especially high (.55). The median validity of the fourth measure of control precision, Rotary Pursuit, is .14.

Test-retest reliability studies were located for two of these four control precision tests. The Rotary Pursuit Test has a test-retest reliability of .88 and the Target Tracking Test 1 has a test-retest reliability of .71. Corrected split-half reliabilities for the other two control precision tests are .83 (Pursuit Confusion Test) and .73 (Dial Setting Test).

Gain score information was located for three tests. The Target Tracking Test 1 has a small trial 2 gain score (+8.3%). The Rotary Pursuit Test and the Dial Setting Test have much larger increases in scores over trials.

Data regarding the correlations of three control precision tests with various cognitive abilities are shown in Table 4. Correlations for the Rotary Pursuit Test and Dial Setting Test are uniformly low, with the highest correlation being .22. Correlations between Target Tracking Test 1 and cognitive abilities are generally higher, with the highest correlation being .41 (with mechanical aptitude).

In summary, several measures of control precision may be useful in Navy selection. One of these tests, the Target Tracking Test 1, is a computerized test. This test presents the examinee with a path of vertical and horizontal lines and a target box with centered crosshairs. As the target box travels along the path, the examinee must use a joystick to keep the crosshairs centered on the target. Over trials, the crosshairs, path speed, target speed, and number of path segments differ. The test has acceptable test-retest reliability, small practice effects, and relatively low correlations with cognitive abilities. Two other measures of control precision, the Dial Setting Test and Pursuit Confusion Test, have relatively high validities; however, no test-retest reliability information was found for either measure.

Finger Dexterity

Table 3 summarizes the validity results for six apparatus measures of finger dexterity. The results indicate that the Purdue Pegboard and Crawford Small Parts Test have median validities of about .30 or greater with various criteria, the GATB-Finger Dexterity Test has a median validity of .20, and the Santa Ana Finger Dexterity, O'Connor Finger Dexterity Test, and Pinboard Test have relatively low validities.

Test-retest reliability results were located for four finger dexterity tests (Purdue Pegboard, O'Connor Finger Dexterity Test, GATB-Finger Dexterity Test, Santa Ana Finger Dexterity Test). These reliabilities range from .68 (Purdue Pegboard) to .87 (O'Connor Finger Dexterity Test). A fifth test, Crawford Small Parts Dexterity Test, has a mean corrected split-half reliability of .89. No reliability information was found for the Pinboard Test.

Information regarding practice effects was found only for the Santa Ana Finger Dexterity Test. Scores on this test show large gains over seven follow-up trials.

Table 4 shows the mean correlations between measures of five finger dexterity tests and several cognitive abilities. These correlations are generally in the .20s and .30s, indicating low to moderate correlations with cognitive abilities. The correlations are generally highest for the Purdue Pegboard, although this may be due to the specific cognitive abilities with which this test was correlated.

Overall, these results suggest that three finger dexterity tests--Purdue Pegboard, GATB-Finger Dexterity, Crawford Small Parts Dexterity

Test--may be useful in prediction. All three of these tests use special apparatus. The Purdue Pegboard requires examinees to insert pegs into holes on a wooden board and to assemble pegs, washers, and collars. The GATB-Finger Dexterity Test has two subtests. One subtest requires subjects to assemble washers onto rivets and then insert the assembled pieces into holes on a test board; the second test involves removing washers from rivets then placing the rivets into holes on another board. The Crawford Small Parts Dexterity Test requires examinees to use a tweezers to pick up and insert pins into holes. The test-retest reliabilities for these tests are adequate and their intercorrelations with cognitive tests are generally low; however, practice information was not found for any of these tests.

<u>Manual Dexterity</u>

The validity results summarized in Table 3 indicate that four manual dexterity tests have validities of .15 or greater across criteria. These are the Minnesota Rate of Manipulation, the GATB-Manual Dexterity, the Stromberg Dexterity Test, and the Hand Tool Dexterity Test. On the other hand, four measures of manual dexterity have mean validities of .10 or lower. These are the Pennsylvania Bi-Manual Work Sample, Formboard Test, Peg Turning, and Peg Placing.

Reliability results were found for five of these manual dexterity tests. Mean test-retest reliabilities are .75 for the GATB-Manual Dexterity and .87 for the Hand Tool Dexterity Test. Reliabilities for three other manual dexterity tests (Minnesota Rate of Manipulation, Stromberg Dexterity Test, Pennsylvania Bi-Manual Work Sample) range from .84 to .90. No reliability information was located for the Formboard, Peg Turning, or Peg Placing tests.

None of the tests measuring manual dexterity reported practice information in the studies reviewed.

Table 4 summarizes the correlations between two manual dexterity tests and various cognitive abilities. Correlations for the Hand-Tool Dexterity Test range from -.02 to .25. Correlations for the GATB-Manual Dexterity test range from .09 to .31.

In summary, three measures of manual dexterity--Minnesota Rate of Manipulation, GATB-Manual Dexterity, and the Hand Tool Dexterity Test--show useful levels of validity for predicting job and training performance. The GATB-Manual Dexterity test and Hand Tool Dexterity Test also have high test-retest reliabilities and relatively low correlations with cognitive tests. No practice information was found for any of these tests. It should be noted, however, that all three tests require special apparatus that might be difficult to adapt to a computer. The Minnesota Rate of Manipulation requires examinees to manipulate a set of 60 blocks, either turning the blocks around or placing them in a different location. The GATB-Manual Dexterity has two similar tests that use pegs instead of blocks. The Hand Tool Dexterity Test requires examinees to transfer bolt, washer, and nut units from one part of a test board to another using simple hand tools (wrench, screwdriver).

Multilimb Coordination

The validity results for nine apparatus and computer measures of multilimb coordination are shown in Table 3. The results indicate that all of these tests have mean validities of .15 or greater across criteria. Four tests--Target Tracking Test 2, Two-Hand Coordination Test (Melton, 1947), Rudder Control Test, Complex Coordination Test (Melton, 1947)--have average validities of .25 or greater. One test, Target Tracking Test 2, had a validity of .51 with a training simulation criterion (see Appendix B).

Reliability results were located for all of these multilimb coordination tests. Test-retest reliabilities for four tests [Target Tracking Test 2, Two-Hand Coordination Test (Melton, 1947), Rudder Control Test, Bi-Manual Coordination Test] range from .72 - .83. Corrected split-half reliabilities for the other tests are all greater than .80.

Four of these tests report data on practice effects. The Target Tracking Test 2 shows a negative gain score of 12.8 percent on trial 2. The other three tests [Two-Hand Coordination Test (Melton, 1947), Rudder Control Test, Complex Coordination Test (Melton, 1947)] have much larger gain scores, although scores on the Rudder Control Test stabilize in relatively few trials.

As shown in Table 4, correlations with cognitive abilities were available for seven of the eight multilimb coordination tests. These correlations are consistently less than .40, with most of the correlations being less than .20.

Based on these results, several measures of multilimb coordination might be useful for selection. Of these, the Target Tracking Test 2 appears to be most promising test. This is a computerized test with good validity, good reliability, small practice effects, and relatively modest correlations with cognitive abilities. This test presents examinees with a path of vertical and horizontal lines and a target box with centered crosshairs. As the target box travels along the path, the examinee must use of two sliding resistors to keep the crosshairs centered on the target. Over trials, the crosshairs, path speed, target speed, and number of path segments differ.

Other multilimb coordination tests with validities greater than .20 and acceptable test-retest reliabilities are the Rudder Control Test, Two-Hand Coordination Test and the Bi-Manual Coordination Test. Practice effects for the Rudder Control Test and Two-Hand Coordination Test are quite large, however.

Rate Control

Table 3 summarizes the validity results for four measures of rate control. Only five validity coefficients were found. The Target Shoot Test has a correlation of .27 with a training simulation criterion (see Appendix B). Validity coefficients for the other three tests are much lower, ranging from -.02 (Motor Judgment Test) to .10 (Single Dimension Pursuitmeter).

Test-retest reliability information was located for the Target Shoot Test. The test-retest reliability of this test, based on four coefficients, is only .50. Mean corrected split-half reliability coefficients for other measures of rate control range from .75 (Rate Control) to .85 (Single Dimension Pursuitmeter).

Practice information was located for only one test--the Target Shoot Test. The Trial 2 gain score is only 5.5 percent, indicating very little change in test performance.

Correlations with cognitive abilities were found for only the Target Shoot Test. As shown in Table 4, these correlations are uniformly low, ranging from .01 to .22.

In summary, there is very little information for measures of rate control. Only five validity coefficients were located for the four tests reviewed. One test, the Target Shoot Test, is computerized. This test has a relatively high validity with a training simulation criterion, small practice effects, and low correlations with cognitive measures, but has a test-retest reliability of only .50. Thus, although data for this construct are very limited, the results suggest that rate control has limited utility for predicting job or training performance.

Speed of Arm Movement

Only one test measuring speed of arm movement was found that had validity information--the Two-Plate Tapping Test. Table 3 indicates that only one validity coefficient was located for this test, a correlation of .07 with a graduation-elimination from training criterion (see Appendix B). The test-retest reliability of this test is high (.91), although the test shows relatively large practice effects over trials. No data were found regarding the correlations of the Two-Plate Tapping Test with various cognitive abilities.

Overall, only one test measuring speed of arm movement was found that had validity information--the Two-Plate Tapping Test. The limited data available suggests this test has little utility for military selection.

Wrist-Finger Speed

Table 3 summarizes validity results for six paper-and-pencil measures of wrist-finger speed. The results indicate that three tests (GATB-Motor Coordination, EAS-Manual Speed and Accuracy, Hand Skills Test) have median validities of .15 or greater across criteria. Among other wrist-finger speed measures, Manual Speed has a validity coefficient of .14, and two tests (Large Tapping Test and Mark Making) have validities less than .05, although the number of validity studies for these tests is small.

Test-retest reliabilities are relatively high for the GATB-Motor Coordination (.85) and EAS-Manual Speed and Accuracy (.77) and somewhat lower for the Hand Skills Test (.68) and Manual Speed (.57). The corrected split-half reliability of the Large Tapping Test is .94. No reliability information was reported for the Mark Making test.

None of the tests measuring wrist-finger speed reported practice information in the studies reviewed.

Correlations with cognitive abilities were found for two of the six wrist-finger speed tests. As shown in Table 4, the GATB-Motor Coordination test has moderate correlations with several cognitive abilities (range: .17 - .49). The Large Tapping Test shows consistently low correlations with cognitive abilities (range: .02 - .14).

These results indicate that the GATB-Motor Coordination and EAS-Manual Speed and Accuracy tests may be the most promising measures of wrist-finger speed. The GATB-Motor Coordination is a highly speeded test that requires the examine to make three short pencil marks (two vertical and a third horizontal line beneath them) in a series of squares. The EAS-Manual Speed and Accuracy test is also a speeded test that requires the examinee to place a pencil dot in as many "O" as possible in five minutes.

Summary: Validity Results for Various Psychomotor Abilities

This section summarizes the validity results presented in Table 3. Summaries of many of the individual validity studies are presented in Appendix B.

More than 2000 validity coefficients are summarized in Table 3. Results indicate that three psychomotor abilities have average validities of .20 or greater across job, training and other criteria. These abilities are multilimb coordination (.27), wrist-finger speed (.21), and manual dexterity (.20). Three other psychomotor abilities have average validities between .10 and .20. These are finger dexterity (.19), and control precision (.17). Four psychomotor abilities have average validities that are less than .10. These abilities are rate control (.09), aiming (.08), speed of arm movement (.07), and arm hand steadiness (.05).

These results are similar to those of McHenry (1987) who recently performed a comprehensive review of the psychomotor test literature. McHenry reported the following median validities for various psychomotor constructs: multilimb coordination (.20), wrist-finger speed (.17), manual dexterity (.19), finger dexterity (.16), control precision (.17), rate control (.06), aiming (.13), speed of arm movement (.10), and arm hand steadiness (.06). McHenry (1987) found the median validity coefficient across all psychomotor abilities was .17.

The average validity for the studies reviewed in Table 3 is .20. The mean validity coefficient is .18 for job criteria, .20 for training criteria, and .20 for "other" criteria. It should be noted that the "other" category includes several GATB test validity studies that used job or training criteria.

Summary: Reliability Results

The test-retest reliabilities for psychomotor tests are generally high. The mean test-retest reliability across all psychomotor tests shown in Table 3 is .75 (range: .37 to .91). The mean corrected split-half and other (e.g., internal consistency) reliability coefficients are .86 and .85, respectively.

Summary: Practice Effects

The available data regarding practice effects suggests that performance on psychomotor tests improves considerably over trials. The mean gain score of the tests reviewed in Table 3 is 47 percent on trial 2, 107 percent on trial 3, and 109 percent on trial 4. It should be noted, however, that these results are based on relatively few studies. Furthermore, a few tests (e.g., Target Tracking Test 1, Target Tracking Test 2, Target Shoot) show little change in second trial mean test score.

These findings regarding practice effects have been corroborated by other researchers. Results from a series of studies conducted at the Naval Medical Research and Development Command (e.g., Kennedy & Bittner, 1977; Kennedy et al., 1980) have shown that psychomotor test scores improve with practice. A recent review of the literature by Adams (1987) summarizes the effects of other practice-related variables such as knowledge of results, distribution of practice, transfer of training, retention, and individual differences on motor skills learning.

Although these results show that scores on most psychomotor tests improve with practice, it should be noted that cognitive tests are also subject to practice effects. For example, Friedman, Streicher, Wing, Grafton, and Mitchell, (1983) examined practice effects for a sample of 1774 Army applicants who completed the same version of the Armed Services Vocational Aptitude Battery (ASVAB) twice during one year. Gain scores ranged from +.16 standard deviations (Mathematics Knowledge) to +.39 standard deviations (Coding Speed). For 26,137 Army applicants who completed different forms of the ASVAB during this year, gain scores ranged from +.08 standard deviations (General Science) to +.43 standard deviations (Coding Speed).

Summary: Correlations Between Psychomotor and Cognitive Abilities

Table 5 shows the median correlations between each psychomotor construct and various cognitive abilities. Summarized in this table are almost 300 individual test-cognitive ability correlations (see Appendix E). The results indicate that psychomotor abilities have relatively low correlations with cognitive abilities. The mean of the 58 psychomotor-cognitive ability correlations is only .16 (range: -.01 - .49). Only nine of these correlations are greater than .25; sixteen correlations are .10 or less.

None of the psychomotor abilities has a mean correlation across cognitive abilities of .25 or greater. Only two psychomotor abilities, aiming and wrist-finger speed, have mean correlations across cognitive abilities as high as .20.

Overall, these results indicate that there is considerable variance in measures of psychomotor ability that is not tapped by cognitive ability tests. Thus, it would appear that psychomotor abilities can contribute unique variance to the prediction of job and training performance.

Table 5

Summary of Correlations Between Psychomotor and Cognitive Abilities

	Cognitive Ability									
Psychomotor Ability	Perceptual Speed and Accuracy	Spatial Ability	Mechanical Aptitude	Verbal Ability	Numerical Aptitude	Reasoning	Science Knowledge	Electronics Knowledge	Auto/Shop Tool Knowledge	Mean Across Cognitive Abilities
Aiming	.31	.21	.11	.21	.19	.16	—	—	—	.20
Arm-Hand Steadiness	.06	.04	.00	.01	-.01	—	—	—	—	.02
Control Precision	.15	.13	.22	.07	.03	.06	.25	.20	.35	.16
Finger Dexterity	.19	.16	.10	.11	.13	.18	—	—	.31	.17
Manual Dexterity	.31	.20	.15	.10	.13	.06	—	—	—	.16
Multilimb Coordination	.15	.18	.32	.12	.06	.17	.05	.18	.36	.18
Rate Control	.02	—	.22	.04	.12	.17	.13	.18	.20	.14
Speed of Arm Movement	—	—	—	—	—	—	—	—	—	—
Wrist-Finger Speed	.49	.14	.14	.32	.34	.24	—	.14	.09	.24

NOTE: The entry in each cell is the median correlation between the psychomotor and cognitive abilities.

Other Issues Related to Psychomotor Assessment

The following sections discuss several issues that are relevant to the utility of psychomotor testing. Included are discussions of the usefulness of complex psychomotor measures, differential stability, and psychomotor testing format (e.g., paper-and-pencil, apparatus, computer tests).

Validity of Complex Psychomotor Tests

The tests reviewed thus far have measured individual psychomotor abilities that were identified by Fleishman (1964). Some researchers have developed "complex" psychomotor tests to measure several psychomotor abilities. These tests are frequently work sample measures.

McHenry (1987) summarized the validity results for several complex psychomotor tests. The tests included in his review are listed below:

- Aetna Drivotron (Farr et al., 1971)
- Aircraft Landing Test (Fowler, 1981)
- AllState Good Driver Test (Farr et al., 1971)
- Automated Pilot Aptitude Measurement System (Hunter and Thompson, 1978)
- Career Determining Exercises (Farr et al., 1971)
- Center-of-Mass Task (Eaton et al., 1980)
- Chalk Carving Test (Mathews and Jensen, 1977)
- Gunner Tracking Task (Campbell and Black, 1982)
- Jump Reaction Time Test (Farr et al., 1971)
- Observer Trainability Tests (Jones, 1982)
- Pistol Firing Test (Osborn and Ford, 1976)
- Round Adjustment Task (Eaton et al., 1980)
- Rudder Timing Reaction Tests (Melton, 1947)
- Timing Reaction Test (Melton, 1947)
- Tracking Test (Melton, 1947)

The median validity for these tests across criteria was only .10 (110 validity coefficients). The median validity for training criteria was .13 (100 coefficients) and .00 for job proficiency criteria (9 coefficients).

Differential Stability

Related to the issues of test reliability and test practice effects discussed earlier is the issue of the test-retest stability. As shown in Table 3, there is considerable evidence that many psychomotor tests have large practice effects. Such gains in test performance could jeopardize the conclusions of studies that involve multiple or repeated trials. As a result, Jones, Kennedy, and Bittner (1981) suggested that scores on repeated measures should be compared only after the point in the learning curve in which practice effects are minimal or nonexistent. They have called this differential stability.

The concept of differential stability was investigated in a series of investigations conducted by researchers at the Naval Medical Research and Development Command in the late 1970s and early 1980s (e.g., Kennedy & Bittner, 1977; Kennedy, Carter, & Bittner, 1980). The purpose of these

studies was to identify a set of cognitive, perceptual and motor tests that could be used to assess the impact of effects of environmental (e.g., ship motion) and time-course effects on test performance using repeated-measures designs. A major outcome of this research program has been a battery of tests called the Performance Evaluation Tests for Environmental Research, or PETER.

The PETER research program has investigated over 140 different performance tests covering a wide range of abilities, including psychomotor ability. Bittner, Carter, Kennedy, Harbeson, and Krause (1986) summarize the utility of 114 different types of tests for repeated measures applications. Six of these are psychomotor oriented tests (Minnesota Rate of Manipulation, Purdue Pegboard, Atari Combat Maneuvering, Spoke Control Task, Aiming, Choice Reaction Time). All of these tests were classified into one of four categories (Recommended, Acceptable-But-Redundant, Marginal, Unacceptable) primarily on the basis of stabilization time and reliability. No validity evidence was presented or considered in making these designations. The results indicated that four psychomotor tests--Minnesota Rate of Manipulation, Atari Combat Maneuvering, Spoke Control Task, Aiming--were in the recommended category and the Aiming and Choice Reaction Time tests were in the acceptable but redundant task features category.

Test Format

Three types of tests have most frequently been used to measure psychomotor ability: paper-and-pencil tests, apparatus tests and computerized tests.

Paper-and-pencil psychomotor tests have a number of advantages: (1) they can easily be administered to large numbers of persons; (2) they enable relatively standardized test administrations; and (3) they are relatively inexpensive to develop and administer. Such measures have one major drawback, however; it is difficult to develop paper-and-pencil measures for several psychomotor abilities (e.g., multilimb coordination, manual dexterity, and finger dexterity).

Apparatus tests have frequently shown relatively high levels of validity and low correlations with cognitive abilities. Such tests have several disadvantages, however, as noted by Melton (1947): (1) they are expensive to develop and maintain; (2) they require frequent maintenance and recalibration; (3) they are less amenable to standardized test administrations because of differences in machines and differences within the same machine over time (due to machine wear); and (4) scores on apparatus tests typically show large gains with practice. In addition, Thorndike (1949) noted that the validation data gathering process can be time-consuming because of the limited number of apparatus tests typically available for use.

Computerized psychomotor tests have several advantages over mechanical apparatus tests (McHenry, 1987; Rosse and Peterson, 1985). One advantage is that computer tests tend to be more reliable operationally and less susceptible to breakdowns or intra-test differences. A second advantage of computer tests over mechanical apparatus tests is that they permit greater standardization in testing conditions. A final advantage of computer tests

is that they can be programmed to automatically record and score the examinee's responses, simplifying scoring and processing.

Rosse and Peterson (1985), however, noted several difficulties with computerized tests. Appropriate hardware may not be available for a particular application. Software is often unavailable and may be expensive and/or difficult to develop. Computers also require periodic recalibration, although generally not as often as mechanical apparatus measures.

Hunt and Pelligrino (1985) discussed other concerns regarding computerized tests. These include: (1) whether computerized tests change the ability under evaluation; (2) whether the computer format leads to individual differences in motivation to perform the task; (3) the effects of keyboard experience on test scores; and (4) the effects of practice on computer test performance.

SECTION 3. SUMMARY AND CONCLUSIONS

Several taxonomies were reviewed for describing the psychomotor ability domain (Fleishman, 1967; Siegel et al., 1980; Imhoff and Levine, 1981; McHenry, 1987). The most thoroughly researched taxonomy was presented by Fleishman and his associates (Fleishman, 1967, 1972). This taxonomy includes eleven psychomotor abilities, nine of which are relevant to this report: multilimb coordination, control precision, rate control, finger dexterity, manual dexterity, wrist-finger speed, aiming, arm-hand steadiness, and speed of arm movement.

To evaluate the utility of these nine abilities, a review of the psychomotor test literature was conducted. Several measures of each psychomotor ability were identified and information was sought regarding their validity, reliability, intercorrelations with cognitive ability, and practice effects. Over 2,000 validity coefficients were located. An evaluation of the validity results indicated that several types of psychomotor abilities may be useful in selection. These include multilimb coordination, wrist-finger speed, manual dexterity, finger dexterity, and control precision. Measures of all five of these abilities had median validity coefficients of .16 of greater. The median validity coefficient across studies was .20 (.18 with job performance criteria, .20 with training criteria, and .20 with other criteria).

The reliability of these psychomotor tests was generally high. The mean test-retest reliability was .75 (range: .37 - .91). Internal consistency and corrected split-half reliabilities were typically in the .80s and .90s.

The correlations between psychomotor and ability tests were generally low. A summary of nearly 300 psychomotor-cognitive ability correlations showed that the mean correlation was only .16 (range: -.01 - .49). The results showed that only two psychomotor abilities, aiming and wrist-finger speed, had mean correlations across cognitive abilities of .20 or greater. Overall, this suggests that there is relatively little overlap between psychomotor abilities and cognitive abilities. Given the low correlations between psychomotor and cognitive measures, inclusion of psychomotor tests in cognitive batteries might lead to increments in overall validity.

Other concerns with psychomotor tests have centered on the use of complex psychomotor tests, differential stability, and use of different testing formats. Each of these issues was briefly discussed.

Based on the research summarized in this this report, several psychomotor abilities are likely to be related to training and job performance criteria in the Navy. These include multilimb coordination, wrist-finger speed, manual dexterity, finger dexterity, control precision. Promising measures of these constructs are listed in Table 6.

Table 6

Promising Measures of Various Psychomotor Abilities

Control Precision	
	Target Tracking Test 1
	Dial Setting Test
	Pursuit Confusion Test
Finger Dexterity	
	Purdue Pegboard
	GATB-Finger Dexterity
	Crawford Small Parts Dexterity Test
Manual Dexterity	
	Minnesota Rate of Manipulation
	GATB-Manual Dexterity
	Hand Tool Dexterity Test
Multilimb Coordination	
	Target Tracking Test 2
	Bi-Manual Coordination Test
	Rudder Control Test
	Two-Hand Coordination Test
Wrist-Finger Speed	
	GATB-Motor Coordination
	EAS-Manual Speed and Accuracy

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APPENDIX A

Brief Descriptions of Selected Psychomotor Tests

BRIEF DESCRIPTIONS OF SELECTED PSYCHOMOTOR TESTS

Arm Hand Steadiness (Melton, 1947)

Construct Measured: Arm Hand Steadiness

This apparatus test consists of a metal plate that has an aperture or hole and a metal stylus. The examinee's task is to hold the stylus within the aperture, minimizing the contact between the stylus and the edge of the aperture. The test consists of eight 30-second trials, each separated by a 15-second rest period. The test score is either the number of contacts or the amount of time the stylus is in contact with the edge of the aperture.

Bi-Manual Coordination Test (Melton, 1947)

Construct Measured: Multilimb Coordination

This apparatus test is intended to measure an individual's ability to coordinate dissimilar movements of the two hands. The test apparatus consists of a metal plate with a serrated pathway cut into the plate. The examinee's task is to move a vertical metal peg through the serrated pathway. The movements of the peg are controlled by two metal bars which protrude from the front of the apparatus. These bars must be operated simultaneously to control peg movement direction. The serrated pathways, which are on both sides of the pathway, trap the peg when erroneous movements are made. The test score is the distance traversed along the pathway.

Complex Coordination Test (Melton, 1947)

Construct Measured: Multilimb Coordination

This apparatus test is designed to measure the ability to make coordinated movements using an airplane-type stick and rudder in response to patterns of visual signals. The test apparatus consists of three double rows of lamps. One row of each pair of lamps has red lights (the signal row) and the other row has green lamps (the response row). When a pattern of lights is presented, the examinee must properly adjust the stick and rudder to match the pattern. After matching the pattern, a new pattern of signal lights is presented and the examinee must adjust the stick and rudder to match the new pattern. The test score is either the number of patterns matched in a fixed time period or the amount of time required to complete a given number of patterns.

Complex Coordination Test (Sanders et al., 1971)

Construct Measured: Multilimb Coordination

This is a computer-administered test. The examinee's task is to adjust a joystick to control the movement of an X-shaped stimulus while simultaneously using a foot-controlled rudder to control a short vertical line near the bottom of the display. Both stimuli make frequent, unpredictable

changes in movement, partially under the control of a computer program. The examinee must attempt to keep the X-shaped stimulus centered at the intersection of the row and column of dots using a joystick and simultaneously keep the second stimulus aligned along the vertical row of dots with a rudder bar using both feet. The test consists of five 1-minute trials, and yields several scores: (1) horizontal deviation of the first stimulus from the target point (X Axis score); (2) vertical deviation of the first stimulus from the target point (Y Axis score); (3) square root of the sum of squares of the X Axis and Y Axis error scores (Generated score); (4) horizontal deviation of the second stimulus from the target point (Z Axis score); and (5) number of times the second stimulus moves off the screen (Reset score).

Crawford Small Parts Dexterity Test

Construct Measured: Finger Dexterity

This apparatus test consists of a 10-inch square board with 3 round wells for holding parts, a metal plate with 42 unthreaded and 42 threaded wells, 2 metal trays under the plate, tweezers, and a small screwdriver. In the first part of the test, the examinee uses a tweezers to pick up pins one at a time (using the preferred hand), inserts each pin into a small hole in the metal plate, and places a collar over it. The examinee does this for six rows of holes. In the second part of the test, the examinee picks up screws and begins threading the screw with the fingers, then finishes the threading using a screwdriver. In this part, both hands are used. The test score is either the time required to complete each part of the test or the number of holes filled for a given amount of time.

Crossing Test (Mullins et al., 1968)

Construct Measured: Aiming

This paper-and-pencil test consists of 144 boxes that have a small square in each corner. The examinee's task is to place an "X" precisely inside as many of these small squares as possible in 4 minutes.

Dial Setting Test (Melton, 1947)

Construct Measured: Control Precision

This apparatus test consists of four dials with knobs and four corresponding stimulus apertures. The examinee's task is to set the four dials to the numbers shown in the apertures. When all four dials are set exactly to the numbers indicated, a new set of numbers is presented in the apertures. The test score is the number of settings completed within a given period of time.

Employee Aptitude Survey - Manual Speed and Accuracy

Construct Measured: Wrist-Finger Speed

This paper-and-pencil test consists of 750 "O"s. The examinee's task is to place a pencil dot in as many "O"s as possible in five minutes. The score is the number of correctly made responses minus the number of incorrect responses.

Flanagan Aptitude Classification Test - Coordination (Flanagan, 1959)

Construct Measured: Aiming

This paper-and-pencil test consists of a series of spiral paths. The examinee's task involves using a pencil to trace within these paths without touching the edges of the path. Two practice and four test trials are given. The test score is a combination of the distance the line is drawn through the pattern and the number of times the line goes outside the path.

Flanagan Aptitude Classification Test - Precision (Flanagan, 1959)

Construct Measured: Aiming

This paper-and-pencil test has two parts. The first part consists of a series of concentric circles or squares. The examinee's task is to use a pencil to draw in the space between concentric circles or squares. The test score is the number of circles or squares completed without drawing over the outside of the concentric circles (squares) during a two minute period. In part two, the examinee must draw circles or squares as in part one; however, the examinee's task is to draw two circles or squares at a time using both hands, with each hand drawing in the opposite direction from the other. The score is the number of circles or squares completed without drawing over the outside of the circles or squares during a two minute period.

Formboard Test (Farr et al., 1971)

Construct Measured: Manual Dexterity

This apparatus test consists of several blocks and forms. The examinee's task is to put the blocks or forms together to form different shapes. The test score is the number of seconds required to put the blocks or forms together.

General Aptitude Test Battery - Finger Dexterity (U.S. Dept. of Labor, 1952)

Construct Measured: Finger Dexterity

Assemble test - This apparatus test consists of a small rectangular board having 50 holes and a supply of small metal rivets and washers. The examinee's task is to pick up a metal rivet from a hole in the upper part of the board with the preferred hand and at the same time remove a washer from a vertical rod with the other hand. The examinee must then put the washer on the rivet and insert the assembled piece into the corresponding hole in the lower part of the board using the preferred hand. The score is the number of parts assembled during the time allowed.

Disassemble test - This apparatus test consists of a lower board having 50 rivets secured into holes with washers and a top board having 50 holes. The examinee's task is to remove the washer from the rivet of the assembly, place the washer on a vertical rod, remove the rivet from the hole, and then place the rivet in an empty hole in the top board. The score is the number of rivets and washers disassembled in the time allowed.

General Aptitude Test Battery - Manual Dexterity (U.S. Dept. of Labor, 1952)

Construct Measured: Manual Dexterity

Placing test - This apparatus test consists of a rectangular board divided into two sections; each section contains 48 holes (four rows of 12 holes). The holes on the upper section are filled with pegs. The examinee's task is to remove the pegs from the holes in the upper section and insert them in the corresponding holes in the lower section, moving two pegs simultaneously, one in each hand. The examinee is given three 15-second trials. The test score is the number of pegs removed from their holes during the three trials.

Turning test - This apparatus test consists of one board that has 48 pegs inserted into holes. The examinee's task is to remove a peg from the hole, turn the peg over so that the opposite end is up, and reinsert the peg in the hole from which it was taken using only the preferred hand. The examinee is given three 15-second trials. The score is the number of pegs turned during the time allowed.

General Aptitude Test Battery - Motor Coordination (U.S. Dept. of Labor, 1952)

Construct Measured: Wrist-Finger Speed

This paper-and-pencil test consists of a series of squares in which the examinee is to make three short pencil marks, two vertical and the third a horizontal line beneath them. The test score is the number of squares marked in 60 seconds.

Hand Skills Test (Cory et al., 1980)

Construct Measured: Wrist Finger Speed

This paper-and-pencil test consists of a series of numbered boxes. In part one of the test, the examinee must make as many tally marks as possible in four separately timed trials. The examinee's tallying base rate is then determined. At the start of each subsequent set of four trials, a "passing" score is announced. The test scores are the number of tallies made on part 3 minus the number of tallies in the examinee's base rate and the number of tallies made on part 4 minus the examinee's base rate.

Hand Tool Dexterity Test (Bennett and Fear, 1943)

Construct Measured: Manual Dexterity

This apparatus test consists of a wooden frame with two uprights attached to a horizontal baseboard and 12 bolt, washer and nut units of differing sizes. The examinee's task is to transfer bolt, washer and nut units from one part of a board to another using hand tools (a crescent wrench, end-wrenches, or a screwdriver). The method of performing the task is left to the examinee. The test score is the time taken to remove all sets of nuts and bolts and washers from the right upright and fasten them onto the left upright.

Large Tapping Test (Fleishman, 1954)

Construct Measured: Wrist-Finger Speed

This paper-and-pencil test consists of six blocks, each containing four rows of 10 large circles. The examinee's task is to place three dots in each circle as rapidly as possible. The test score is the number of circles marked with three dots in two minutes.

Line Control (Mullins et al., 1968)

Construct Measured: Arm-Hand Steadiness

This paper-and-pencil test consists of a maze containing 80 small openings. The examinee's task is to trace through a series of openings in a maze pattern without touching the maze lines. The test score is the number of small openings traced without touching the maze lines in 1 minute.

Manual Speed (Cory et al., 1980)

Construct Measured: Wrist-Finger Speed

This paper-and-pencil test is similar to the Hand Skills Test but was designed to eliminate hand scoring. The test consists of a series of circles on an optical mark reader answer sheet. In the first part of the test, the

examinee blackens as many tally circles as possible in four separately timed trials. The examinee's base rate is then determined. At the start of each subsequent set of four trials, a "passing" score is announced. The test scores are the number of circles blackened on part 3 minus the examinee's base rate and the number of circles blackened on part 4 minus the examinee's base rate.

Mark Making Test (Mathews & Jensen, 1977)

Construct Measured: Wrist-Finger Speed

This paper-and-pencil test requires the examinee to make three pencil marks in a series of boxes. The examinee must make two vertical lines and a 0 between them. The test includes a 10-second practice period and a 20-second practice period. The test score is the score on a followup 60-second period.

Minnesota Rate of Manipulation Test

Construct Measured: Manual Dexterity

Turning test. This apparatus test consists of a large board having 60 holes and 60 cylindrical blocks. The examinee's task is to remove the blocks from the holes with one hand, turn the blocks over with the other hand and reinsert the blocks into the same holes as rapidly as possible. The test score is either the total time required for the examinee to turn all 60 blocks or the number of blocks turned within a given amount of time.

Placing test. This apparatus test consists of two boards, each containing 60 holes (four rows of 15 holes). The holes on one board are filled with blocks. The examinee's task is to place as many of the blocks into the proper holes on the second board as rapidly as possible. The test has two 40-second trials. The test score is either the total time required for the examinee to place all 60 blocks or the number of blocks placed within a given amount of time.

Motor Judgment Test (Farr et al., 1971)

Construct Measured: Rate Control

This apparatus test consists of two adjacent disks which rotate at a constant speed. Each disk has black and white sections on its perimeter. Between these disks is a pointer whose speed of rotation can be controlled with a control stick. The examinee cannot stop the rotation of this pointer nor exert control over the two rotating disks. The examinee's task is to manipulate the control stick so that the pointer makes as many revolutions as possible without crossing the black areas on the rotating disks. The test score is the ratio of pointer revolutions to errors (crossings of the black areas on the rotating disks) during four 1-minute trials.

O'Connor Finger Dexterity Test

Construct Measured: Finger Dexterity

This apparatus test consists of a plate containing 100-3/16 inch holes and a metal tray containing 310 one-inch metal pins. The examinee's task is to place three pins in each hole as quickly as possible using only one hand. The examinee's score is the number of holes filled with three pins at the end of three minutes.

Peg Placing (Mathews & Jensen, 1977)

Construct Measured: Manual Dexterity

This apparatus test consists of a rectangular pegboard divided into two sections, each containing 48 cylindrical holes. Forty eight cylindrical pegs are placed in upper part of the pegboard. The examinee's task is to remove two pegs from the upper part of the pegboard, one in each hand, and place them in corresponding holes in the bottom part. The examinee is given three 15-second trials to remove as many pegs as possible. The test score is the number of pegs successfully transferred by the examinee during the three trials.

Peg Turning (Mathews & Jensen, 1977)

Construct Measured: Manual Dexterity

This apparatus test consists of a rectangular pegboard divided into two sections, each containing 48 cylindrical holes. Forty eight cylindrical pegs are placed in upper part of the pegboard. The examinee's task is to remove one wooden peg from a hole and using only hand, turn the peg upside down and put it into the hole. The examinee is given three 15-second trials to turn as many pegs as possible. The test score is the total number of pegs successfully turned and replaced during the three trials.

Pennsylvania Bi-Manual Worksample

Construct Measured: Manual Dexterity

Assembly test. This apparatus test consists of an 8 x 24-inch board containing 100 holes arranged in 10 rows and a set of bolts and nuts. The examinee's task is to hold a nut between the thumb and index finger of one hand and a bolt between the thumb and index finger of the other hand, turn the bolt into the nut, then place both in a hole in the board. Twenty practice trials are allowed, and 80 trials are timed. The test score is the time to complete the task.

Disassembly test. This test uses the same apparatus described in the assembly test. The examinee's task is to disassemble the nuts and bolts. The test score is the time to complete the task.

Pinboard Test (Farr et al., 1971)

Construct Measured: Finger Dexterity

This apparatus test consists of a board with holes and several small pins. The examinee's task is to pick up the pins from a tray and stick them into holes on a board. The pins may be manipulated either by hand or using tweezers. The score is the number of pins placed into the board in a given amount of time.

Purdue Pegboard

Construct Measured: Finger Dexterity

This apparatus test consists of a wooden board with two rows of 25 holes into which pegs are inserted. At the top of the board are four trays containing pegs, washers, and collars. The test produces several scores which are briefly described below.

<u>Right hand score</u>. The examinee's task is to pick up one peg at a time from the tray with the right hand and insert the peg into one of the holes in the board. The test score is the number of pegs inserted in one 30-second trial.

<u>Left hand score</u>. The examinee's task is to pick up one peg at a time from the tray with the left hand and insert the peg into one of the holes in the board. The test score is the number of pegs inserted in one 30-second trial.

<u>Both hands score</u>. The examinee's task is to pick up two pegs at a time from the tray, one with the right hand and one with the left hand, and insert them into holes in the board. The test score is the number of pegs inserted in one 30-second trial.

<u>Assembly score</u>. The examinee's task is to assemble peg-washer-collar combinations as quickly as possible. The test score is the number of peg-washer-collar combinations assembled in one 30-second trial.

<u>Summation score</u>. This score consists of the sum of the four above scores.

Pursuit Confusion Test (Fleishman, 1956)

Construct Measured: Control Precision

This apparatus test requires the examinee to keep a stylus on a variable speed target as it moves through a diamond-shaped slot. The entire target area is visible only by mirror vision. The test score is either is the time-on-target during six 1-minute trials or the amount of time the stylus is in contact with the sides of the slot.

Rate Control (Melton, 1947)

Construct Measured: Rate Control

This apparatus test consists of a box containing a curved scale. A vertical target line moves back and forth across this scale, making frequent changes in direction and speed. The examinee's task is to keep a pointer in coincidence with this line by adjusting a rotary knob which controls movement of the pointer. The test score is the total amount of time the pointer and target line are in coincidence during eight 1-minute trials.

Rotary Pursuit Test (Melton, 1947)

Construct Measured: Control Precision

This apparatus test requires the examinee to keep a stylus in contact with a small metallic target while the target is rapidly revolving near the edge of a phonograph-like disk. The test score is total amount of time on target during five 20-second trials.

Rudder Control Test (Melton, 1947)

Construct Measured: Multilimb Coordination

This apparatus test consists of a mock airplane cockpit device. The examinee's task is to keep the cockpit directly lined up with one of three target lights as they come on in front of him/her. The examinee's own weight throws the cockpit off balance unless a proper correction is made using foot pedals. The examinee must also use the proper pedal control to shift the cockpit from one light to another as these come on at random intervals. The test score is total amount of time the cockpit is lined up with the proper light during three 112-second trials.

Santa Ana Finger Dexterity Test (Melton, 1947)

Construct Measured: Finger Dexterity

This apparatus test consists of a test board with square holes and 48 pegs having square bottoms and round tops. The top of each peg is half blue and half yellow. At the beginning of the test, the pegs are all turned so that the same color of each peg top is nearest the examinee. The examinee's task is to pick up each peg, turn it 180 degrees, and reinsert the peg into the hole. The test has five 35-second trials. The test score is the number of pegs turned and reinserted into the board during five trials.

Single Dimension Pursuitmeter (Melton, 1947)

Construct Measured: Rate Control

This apparatus test requires the examinee to make compensatory adjustments (in and out movements) using a control wheel to keep a horizontal line in a

given position as it moves off center in irregular fashion. This control wheel has been adjusted pneumatically to introduce a lag into the system. The test score is either the time the horizontal line is held in a null position during the four 1-minute trials (timer score) or the total amount of movement of the wheel during the attempt to keep the bar centered (work-adder score). The test has four 1-minute trials, separated by 15-second rest periods.

Small Tapping Test (Fleishman & Hempel, 1954)

Construct Measured: Aiming

This paper-and-pencil test consists of four rows of 10 small circles. The examinee's task is to place one dot in each circle as rapidly as possible. The test score is the number of circles having a pencil dot. Testing time is 1 minute.

Steadiness Aiming Test (Melton, 1947)

Construct Measured: Arm Hand Steadiness

This apparatus test consists of a stylus resting in a pivoted holder. The stylus handle extends down from the holder at a steep angle; the stylus tip is inserted inside a narrow hole. The examinee's task is to hold the stylus handle in such a manner that the stylus tip does not touch the sides of the hole. The test includes six 40-second trials. The test scores are the total number of contacts between the stylus and the sides of the hole and the amount of time the stylus is in contact with the sides the hole.

Stromberg Dexterity Test

Construct Measured: Manual Dexterity

This apparatus test consists of a tricolored form board with flat disks. The examinee's task is to transfer the disks as rapidly as possible in a designated order from one board to another. This is done twice. Each disk must be moved in a different manner from the other disks. The test score is the time taken to transfer all the disks. Testing time is 8 to 15 minutes.

Target Shoot Test (McHenry, 1987)

Construct Measured: Rate Control

This is a computerized test that uses a joystick. For each trial, the examinee is presented with a crosshair in the middle of the screen and a target box at some other location on the screen. This target moves in unpredictable directions, changing both speed and direction. The examinee's task is to use the joystick to center the crosshairs on the target and then press a RED button on the response pedestal to "fire" at the target. This must be done within a certain amount of time. The test produces three scores: the percentage of "hits," the mean time before the examinee

fires at the target, and the mean distance from the center of the crosshair to the center of the target at the time the examinee fires at the target. The test has 30 trials.

Target Tracking Test 1 (McHenry, 1987)

Construct Measured: Control Precision

This is a computerized pursuit tracking test that uses a joystick. For each trial, the examinee is presented a path of vertical and horizontal lines. At the beginning of the path there is a target box with centered crosshairs. This target box travels along the path at a constant rate of speed. The examinee's task is to use a joystick to keep the crosshairs centered on the target. Over trials, the crosshairs, path length, target speed, and number of path segments vary. The test score is the mean distance from the center of the crosshair to the center of the target across 18 trials.

Target Tracking Test 2 (McHenry, 1987)

Construct Measured: Multilimb Coordination

This is a computerized pursuit tracking test measuring multilimb coordination. The test is similar to Target Tracking Test 1 except that the examinee must use two sliding resistors instead of a joystick to control the movement of the crosshair. One resistor controls vertical crosshair movement and the other resistor controls horizontal crosshair movement. The examinee's task is to keep the crosshairs centered on the target. Over trials, the crosshairs, path length, target speed, and number of path segments vary. The test score is the mean distance from the center of the crosshair to the center of the target across 18 trials.

Trace Tapping I (Mullins et al., 1968)

Construct Measured: Aiming

This paper-and-pencil test consists of 100 circles connected by a line. The examinee's task is to follow the pattern of circles placing one dot in each circle around the pattern. The test score is the number of circles that are dotted in 30 seconds.

Trace Tapping II (Mullins et al., 1968)

Construct Measured: Aiming

This paper-and-pencil test is similar to Trace Tapping I except the pattern is more complex and the circles are smaller. The test consists of several circles connected by an irregularly shaped line. The examinee's task is to follow the pattern of circles placing one dot in each circle around the pattern. The test score is the number of circles that are dotted in a given time period.

Tracing (Mullins et al., 1968)

Construct Measured: Aiming

This paper-and-pencil test consists of a maze with a series of small openings. The examinee's task is to trace between a pair of narrowly separated lines 1 millimeter apart which form a pattern. The test has two patterns and a 2 minute time limit. The test score is the number of openings successfully encountered through minus the number of openings unsuccessfully negotiated.

Two-Hand Coordination (Melton, 1947)

Construct Measured: Multilimb Coordination

This apparatus test consists of a phonograph-like turntable which has a mounted brass disk. The disk rotates clockwise along an irregular path at varying speeds. The examinee's task is to keep a metal leaf in continuous contact with this disk. The leaf's position is controlled by two rotating handles. The handles can be manipulated simultaneously, so that the leaf can move in any direction along the top of the "turntable." The test has a fixed number of 1-minute trials separated by 15-second rest periods. The test score is the total time the leaf is in contact with the disk.

Two-Hand Coordination (Sanders et al., 1971)

Construct Measured: Multilimb Coordination

This is a computerized test that requires the examinee to use two joysticks to control the position of an X-shaped cursor shown on a video screen. The examinee's task is to maintain the position of the X as close as possible to a triangular target, which moves in a circular path at varying speeds. The target's velocity changes continuously throughout the test. The test has five 1-minute trials. The test produces three error scores: (1) horizontal deviation of the first stimulus from the target point (i.e., X Axis score); (2) vertical deviation of the first stimulus from the target point (i.e., Y Axis score); and (3) the square root of the sum of squares of the X Axis and Y Axis error scores (i.e., Generated score).

Two-Hand Pursuit (Melton, 1947)

Construct Measured: Multilimb Coordination

This apparatus test consists of a bright metal target located inside a black box and superimposed against a movable black background. The target and the background move in irregular paths at differing speeds. The examinee views the target and background through a tubular eyepiece located on the top of the box. The examinee's task is to keep the target centered directly beneath a small button located at the intersection of a set of crosswires. Both the button and the crosswires are mounted at the center

of the bottom of the eyepiece. The examinee controls the movement of the target by manipulating two handles, which can be manipulated simultaneously. The test consists of eight 1-minute trials. The test score is the total time the target is centered directly beneath the metal button.

Two-Plate Tapping Test (Melton, 1947)

Construct Measured: Speed of Arm Movement

This apparatus test consists of two adjacent metal plates and a stylus. The examinee's task is to strike the adjacent plates successively (i.e., one plate, then the other) as rapidly as possible. The number of taps is recorded using counters. The test score is the number of taps made during six 30-second trials.

APPENDIX B

Validity Results for Selected Measures of

Nine Psychomotor Constructs

Validity Results for Selected Measures of Nine Psychomotor Constructs

Construct Aiming

Test	Sample	N	Criterion Type: Job	Criterion Type: Trg	Criterion Type: Ed	Description of Criterion	Validity Results	Reference
Trace Tapping II	South Vietnamese Air Force pilot trainees	244		X		graduation-elimination from pilot training	.29	Croll, 1973
"	Air Force pilot trainees	245		X		graduation-elimination from pilot training	.05	Hunter & Thompson, 1978
"	foreign students	120		X		graduation-elimination from pilot training	-.08	Mullins et al., 1968
	foreign pilot trainees	90		X		graduation-elimination from pilot training	-.03	Mullins et al., 1968
Small Tapping Test	foreign pilot trainees	120		X		graduation-elimination from pilot training	-.09	Mullins et al., 1968
"	foreign pilot trainees	90		X		graduation-elimination from pilot training	-.05	Mullins et al., 1968
Crossing Test	foreign pilot trainees	120		X		graduation-elimination from pilot training	-.11	Mullins et al., 1968
"	foreign pilot trainees	90		X		graduation-elimination from pilot training	-.07	Mullins et al., 1968
Tracing	foreign pilot trainees	120		X		graduation-elimination from pilot training	-.03	Mullins et al., 1968
"	foreign pilot trainees	90		X		graduation-elimination from pilot training	.03	Mullins et al., 1968
Trace Tapping I	foreign pilot trainees	120		X		graduation-elimination from pilot training	-.04	Mullins et al., 1968
"	foreign pilot trainees	90		X		graduation-elimination from pilot training	.00	Mullins et al., 1968
FACT Precision	high school seniors	275	X			rate of salary increase	-.13	Test Manual, 1959
"	high school seniors	51	X			rate of salary increase	.36	Test Manual, 1959
"	high school seniors	33	X			rate of salary increase	.51	Test Manual, 1959
"	assemblers	86				unknown	-.01	Test Manual, 1959
"	clerks	267				unknown	.06	Test Manual, 1959

Construct Aiming (Continued)

Test	Sample	N	Criterion Type: Job	Trg	Ed	Description of Criterion	Validity Results	Reference
FACT Precision	draftsmen	99				unknown	-.12	Test Manual, 1959
"	electronics technicians	101				unknown	.19	Test Manual, 1959
"	electricians	216				unknown	.14	Test Manual, 1959
"	gas servicemen	223				unknown	-.02	Test Manual, 1959
"	machinists	264				unknown	.15	Test Manual, 1959
"	telegraphers	190				unknown	.12	Test Manual, 1959
"	packers	89				unknown	.20	Test Manual, 1959
"	secretaries	104				unknown	.15	Test Manual, 1959
"	railroad yard clerks	390				unknown	.05	Test Manual, 1959
FACT Coordination	pre-medical students	134			X	college grade-point average	.06	Test Manual, 1959
"	high school seniors	45	X			rate of salary increase	.66	Test Manual, 1959
"	high school seniors	15	X			rate of salary increase	.10	Test Manual, 1959
"	assemblers	86	X			supervisor rankings of job success	.12	Test Manual
"	carpenters	144	X			supervisor rankings of job success	.11	Test Manual
"	draftsmen	99	X			supervisor rankings of job success	.03	Test Manual
"	electronics technicians	101	X			supervisor rankings of job success	.07	Test Manual
"	electricians	216	X			supervisor rankings of job success	.07	Test Manual
"	gas servicemen	223	X			supervisor rankings of job success	.05	Test Manual
"	machinists	264	X			supervisor rankings of job success	.10	Test Manual
"	maintenance mechanics	141	X			supervisor rankings of performance	.00	Test Manual
"	packers	89	X			supervisor rankings of performance	.11	Test Manual

Construct Aiming (Continued)

Test	Sample	N	Criterion Type: Job	Criterion Type: Trg	Criterion Type: Ed	Description of Criterion	Validity Results	Reference
FACT Coordination	plumbers	90	X			supervisor rankings of performance	.30	Test Manual
"	railroad engineers	178	X			supervisor rankings of performance	-.02	Test Manual
"	trainmen/switchmen	163	X			supervisor rankings of performance	.01	Test Manual
"	yard clerks	390	X			supervisor rankings of performance	.04	Test Manual

Construct Arm Hand Steadiness

Test	Sample	N	Criterion Type: Job	Criterion Type: Trg	Criterion Type: Ed	Description of Criterion	Validity Results	Reference
Arm Hand Steadiness Test	Army Air Forces aviation students	185		X		graduation-elimination from navigator training	-.03	Melton, 1947
"	Army Air Forces aviation students	147		X		graduation-elimination from navigator training	-.08	Melton, 1947
"	Army Air Forces aviation students	116		X		graduation-elimination from navigator training	.25	Melton, 1947
"	Army Air Forces aviation students	86		X		bombing accuracy score	.15	Melton, 1947
"	Army Air Forces aviation students	144		X		bombing accuracy score	.00	Melton, 1947
"	Army Air Forces aviation students	101		X		bombing accuracy score	.06	Melton, 1947
"	Army Air Forces aviation students	248		X		graduation-elimination from pilot training	.12	Melton, 1947
"	Army Air Forces aviation students	1,942		X		graduation-elimination from pilot training	.09	Melton, 1947
"	Army Air Forces aviation students	797		X		graduation-elimination from pilot training	.15	Melton, 1947
"	Army Air Forces aviation students	131		X		graduation-elimination from pilot training	.06	Melton, 1947
"	Army Air Forces aviation students	1,520		X		graduation-elimination from pilot training	.02	Melton, 1947

Construct <u>Arm Hand Steadiness (Continued)</u>

Test	Sample	N	Criterion Type: Job	Criterion Type: Trg	Criterion Type: Ed	Description of Criterion	Validity Results	Reference
Arm Hand Steadiness Test	Army Air Forces aviation students	1,148		X		graduation-elimination from pilot training	.04	Melton, 1947
"	Army Air Forces aviation students	256		X		graduation-elimination from pilot training	.02	Melton, 1947
"	Army Air Forces elementary students	516		X		graduation-elimination from from pilot training	.13	Melton, 1947
Line Control	foreign pilot trainees	120		X		graduation-elimination from pilot training	-.10	Mullins et al., 1968
"	foreign pilot trainees	90		X		graduation-elimination from pilot training	-.09	Mullins et al., 1968

Construct <u>Control Precision</u>

Test	Sample	N	Criterion Type: Job	Criterion Type: Trg	Criterion Type: Ed	Description of Criterion	Validity Results	Reference
Rotary Pursuit Test	Army Air Forces pilot trainees in 10 classes	12,884		X		graduation-elimination from from pilot training	median .22	Melton, 1947
"	Army Air Forces navigator trainees in 2 classes	1,750		X		graduation-elimination from navigator training	median .04	Melton, 1947
"	Army Air Forces bombardier trainees in 6 classes	3,150		X		graduation-elimination from bombardier training	median .14	Melton, 1947
"	Army Air Forces advanced pilot trainees in 3 classes	1,193		X		Gunnery training proficiency scores	median .02	Melton, 1947
"	Army Air Forces radar operator trainees	47		X		flight and ground trainer grades	.02	Melton, 1947
"	Army Air Forces advanced pilot trainees	562		X		instructor ratings of flying proficiency	.01	Melton, 1947
"	Army Air Forces pilot trainees in 2 classes	4,311		X		graduation-elimination from pilot training	median .27	Fleishman, 1954
"	foreign military pilot trainees	120		X		graduation-elimination from pilot training	.03	Mullins et al., 1968
"	Army helicopter pilot trainees	249		X		graduation-elimination from helicopter pilot training	.22	Zeidner et al., 1951
Pursuit Confusion Test	unknown	un-known		X		graduation-elimination from pilot training	.30	Fleishman, 1956

Construct Control Precision (Continued)

Test	Sample	N	Criterion Type: Job	Trg	Ed	Description of Criterion	Validity Results	Reference
Dial Setting Test	Army Air Forces elementary pilot trainees	400		X		graduation-elimination from elementary pilot training	.10	Melton, 1947
"	Army Air Forces aviation students	74		X		graduation-elimination from bombardier training	.40	Melton, 1947
Target Tracking Test 1	Army Armor officer trainees	95		X		gunnery skills proficiency composite	.55	Smith & Graham, in press

Construct Finger Dexterity

Test	Sample	N	Criterion Type: Job	Trg	Ed	Description of Criterion	Validity Results	Reference
Santa Ana Finger Dexterity Test	Air Forces elementary pilot trainees in 17 classes	26,032		X		graduation-elimination from training	median .07	Melton, 1947
"	Air Force pilot trainees	2,010		X		graduation-elimination from training	.11	Craeger, 1957
"	Navy pilot trainees in 2 classes	1,368		X		graduation-elimination from training	median .08	Payne et al., 1952
"	aviation cadets	1,016		X		graduation-elimination from training	.11	Zaccaria & Cox, 1952
"	student officers	547		X		graduation-elimination from training	.06	Zaccaria & Cox, 1952
"	Air Force advanced pilot trainees in 2 classes	3,538		X		graduation-elimination from training	.09	Leiman & Friedman, 1952
"	Army Air Forces pilot trainees	311		X		average check ride grade	.06	Melton, 1947
"	Army Air Forces pilot trainees	1,000		X		instructor ratings on 6 training performance measures	median .14	Melton, 1947
"	Army Air Forces pilot trainees in 4 classes	1,716		X		gunnery proficiency scores	median .08	Melton, 1947
"	Army Air Forces pilot trainees	562		X		instructor ratings of flying proficiency	-.04	Melton, 1947
"	Army Air Forces navigation trainees	2,481		X		graduation-elimination from navigator training	.14	Melton, 1947
"	Army Air Forces bombardier trainees in 9 classes	4,454		X		graduation-elimination from bombardier training	median .13	Melton, 1947

Construct Finger Dexterity (Continued)

Test	Sample	N	Criterion Type: Job	Trg	Ed	Description of Criterion	Validity Results	Reference
Santa Ana Finger Dexterity Test	Army Air Forces lead bombardiers	32	X			percent of "on target" bombs in combat	-.32	Melton, 1947
"	Army Air Forces remote-control turret gunners	164	X			gunnery accuracy	.22	Melton, 1947
"	Army Air Forces radar operator trainees	69		X		composite flight and ground trainer grades	.19	Melton, 1947
Purdue Pegboard (right hand)	light machine operators	17	X			amount of pay	.56	Test Manual, 1948
Purdue Pegboard (both hands)	light machine operators	17	X			amount of pay	.21	Test Manual, 1948
Purdue Pegboard (sum of right hand and both hands)	light machine operators	17	X			amount of pay	.31	Test Manual, 1948
Purdue Pegboard (assembly)	light machine operators	17	X			amount of pay	.38	Test Manual, 1948
Purdue Pegboard (assembly)	textile workers	28	X			production index	.15	Test Manual, 1948
Purdue Pegboard (right hand)	small parts assemblers	15	X			production index	.76	Test Manual, 1948
Purdue Pegboard (assembly)	small parts assemblers	15	X			production index	.76	Test Manual, 1948
Purdue Pegboard (assembly)	radio tube mounters	233	X			supervisor ratings	.64	Surgent, 1947
Purdue Pegboard (assembly)	Israeli high school students	224			X	shop mechanics course grades	.70	Rim, 1962
Purdue Pegboard (assembly)	electric shaver repairmen	11	X			composite supervisory ratings	.07	Bruce, 1954
Purdue Pegboard (right hand)	bank proof machine operators	57	X			average number of items sorted per hour over a 6-month period	.18	Shore, 1958
Purdue Pegboard (left hand)	bank proof machine operators	57	X			average number of items sorted per hour over a 6-month period	.13	Shore, 1958

Construct Finger Dexterity (Continued)

Test	Sample	N	Criterion Type: Job	Trg	Ed	Description of Criterion	Validity Results	Reference
Purdue Pegboard (both hands)	bank proof machine operators	57	X			average number of items sorted per hour over a 6-month period	.29	Shore, 1958
Purdue Pegboard (sum of right, left, both hands)	bank proof machine operators	57	X			average number of items sorted per hour over a 6-month period	.22	Shore, 1958
Purdue Pegboard (assembly)	bank proof machine operators	57	X			average number of items sorted per hour over a 6-month period	.61	Shore, 1958
O'Connor Finger Dexterity	Israeli High School Students	224			X	shop mechanics course grades	.33	Rim, 1962
"	female sewing machine operators in 8 plants	1,092	X			piece-rate pay	median .04	[illegible]skeep, 1971
"	gas appliance service workers	60	X			supervisor overall performance rating	.18	Laney, 1951
"	gas appliance service trainees	75		X		training grades	.28	Laney, 1951
"	female sewing machine trainees	116	X			work sample: quality/speed	.20	Otis, 1938
"	packers and wrappers	44	X			productivity rating	.02	Blum & Candee, 1941
"	packers and wrappers	38	X			productivity rating	.08	Blum & Candee, 1941
"	packers and wrappers	42	X			supervisor ratings of quality/quantity	.02	Blum & Candee, 1941
"	male vocational guidance clients	49	X			work sample (assembling an electric bell)	.08	Steel et al., 1945
"	female vocational guidance clients	35	X			work sample (assembling an electric bell)	.37	Steel et al., 1945
GATB - Finger Dexterity	105 studies - professional, technical, managerial jobs		X	X	X	various educational, training, job performance criteria	median .12	Droege, 1968 U.S. Dept. of Labor, 1970
"	47 studies - clerical jobs		X	X	X	various educational, training, job performance criteria	median .13	Droege, 1968 U.S. Dept. of Labor, 1970
"	5 studies - sales jobs		X	X	X	various educational, training, job performance criteria	median .08	Droege, 1968 U.S. Dept. of Labor, 1970

Construct Finger Dexterity (Continued)

Test	Sample	N	Criterion Type Job	Criterion Type Trg	Criterion Type Ed	Description of Criterion	Validity Results	Reference
GATB - Finger Dexterity	5 studies - protective service jobs		X	X	X	various educational, training, job performance criteria	median .10	Droege, 1968 U.S. Dept. of Labor, 1970
"	47 studies - service jobs		X	X	X	various educational, training, job performance criteria	median .14	Droege, 1968 U.S. Dept. of Labor, 1970
"	59 studies - maintenance jobs		X	X	X	various educational, training, job performance criteria	median .20	Droege, 1968 U.S. Dept. of Labor, 1970
"	10 studies - electronics jobs		X	X	X	various educational, training, job performance criteria	median .16	Droege, 1968 U.S. Dept. of Labor, 1970
"	257 studies - industrial jobs		X	X	X	various educational, training, job performance criteria	median .25	Droege, 1968 U.S. Dept. of Labor, 1970
"	27 studies - miscellaneous jobs		X	X	X	various educational, training, job performance criteria	median .18	Droege, 1968 U.S. Dept. of Labor, 1970
Crawford Small Parts Dexterity Test (Part 1)	electronic assembly workers	80	X			supervisor ratings	.17	Test Manual, 1956
" (Part 2)	electronic assembly workers	80	X			supervisor ratings	.49	Test Manual, 1956
" (Part 1)	electronic assembly workers	70	X			supervisor ratings	.25	Test Manual, 1956
" (Part 2)	electronic assembly workers	70	X			supervisor ratings	.30	Test Manual, 1956
" (Part 1)	electronic assembly trainees	40		X		ratings by training instructors	.36	Test Manual, 1981
" (Part 2)	electronic assembly trainees	40		X		ratings by training instructors	.37	Test Manual, 1981
" (Part 1)	mentally handicapped trainees	28	X			productivity measures	.40	Test Manual, 1981
" (Part 2)	mentally handicapped trainees	28	X			productivity measures	.37	Test Manual, 1981

Construct Finger Dexterity (Continued)

Test	Sample	N	Criterion Type: Job	Criterion Type: Trg	Criterion Type: Ed	Description of Criterion	Validity Results	Reference
Crawford Small Parts Dexterity Test (Part 2)	female menders	56	X			high vs. low piece-rate earnings	.76	Test Manual, 1981
"	Israeli high school students	224			X	shop mechanics course grades	.29	Rim, 1962
" (Part 1)	telephone installation trainees	430		X		training performance	.24	Grant & Bray, 1970
" (Part 2)	telephone installation trainees	430		X		training performance	.19	Grant & Bray, 1970
" (Part 1)	relay adjusters	53	X			dichotomous (good/poor ratings)	.32	Speer, 1957
" (Part 2)	relay adjusters	53	X			dichotomous (good/poor ratings)	.95	Speer, 1957
" (Part 2)	electric shaver repairmen	11	X			manager ratings on 10 dimensions	.36	Bruce, 1954
" (Part 1)	female electrical equipment assemblers	139	X			supervisor ratings	.02	Fitzpatrick & McCarty, 1955
" (Part 2)	female electrical equipment assemblers	139	X			supervisor ratings	.02	Fitzpatrick & McCarty, 1955
" (Part 1)	female electrical equipment assemblers	139	X			performance efficiency	.11	Fitzpatrick & McCarty, 1955
" (Part 2)	female electrical equipment assemblers	139	X			performance efficiency	.17	Fitzpatrick & McCarty, 1955
Pinboard Test	sewing machine operators	69		X		6 measures of training success	median .02	Farr et al., 1971
"	sewing machine operators	98	X			3 measures of turnover	median .15	Farr et al., 1971

Construct Manual Dexterity

Minnesota Rate of Manipulation Test (placing)	bank proof machine operator	57	X			average number of items sorted per hour over 6-month period	.08	Shore, 1958

Construct Manual Dexterity (Continued)

Test	Sample	N	Criterion Type: Job	Trg	Ed	Description of Criterion	Validity Results	Reference
Minnesota Rate of Manipulation Test (turning)	bank proof machine operator	57	X			average number of items sorted per hour over 6-month period	.13	Shore, 1958
" (placing)	seasonal wrappers and packers in a department store	52	X			average daily number of packages wrapped over 1 month	.35	Blum & Candee, 1941
" (turning)	seasonal wrappers and packers in a department store	52	X			average daily number of packages wrapped over 1 month	.27	Blum & Candee, 1941
" (placing)	permanent wrappers and packers in a department store	36	X			average daily number of packages wrapped over 1 month	.21	Blum & Candee, 1941
" (turning)	permanent wrappers and packers in a department store	36	X			average daily number of packages wrapped over 1 month	.06	Blum & Candee, 1941
" (turning)	female factory employees	72	X			dichotomous high/low job performance	.00	Drewes, 1961
" (sum of placing, turning, and displacing scores)	Israeli high school students	224			X	shop mechanics course grades	.81	Rim, 1962
"	soap packers in a factory in India	60	X			supervisor ratings of quickness in soap wrapping	.24	Shanthamani, 1978
"	soap packers in a factory in India	15	X			individual production records	.52	Shanthamani, 1978
" (placing)	paper mill employees	60				unknown	.32	Test Manual, 1969
" (left hand turning)	paper mill employees	60				unknown	.46	Test Manual, 1969
GATB - Manual Dexterity	105 studies - professional, technical, managerial jobs		X	X	X	various education, training proficiency criteria	median .12	U.S. Dept. of Labor, 1970; Droege, 1968
"	47 studies - clerical jobs		X	X	X	various education, training proficiency criteria	median .13	U.S. Dept. of Labor, 1970; Droege, 1968
"	5 studies - sales jobs		X	X	X	various education, training proficiency criteria	median .08	U.S. Dept. of Labor, 1970; Droege, 1968

Construct Manual Dexterity (Continued)

Test	Sample	N	Criterion Type: Job	Trg	Ed	Description of Criterion	Validity Results	Reference
GATB - Manual Dexterity	5 studies - protective service jobs		X	X	X	various education, training proficiency criteria	median .15	U.S. Dept. of Labor, 1970; Droege, 1968
"	47 studies - service jobs		X	X	X	various education, training proficiency criteria	median .18	U.S. Dept. of Labor, 1970; Droege, 1968
"	60 studies - maintenance jobs		X	X	X	various education, training proficiency criteria	median .20	U.S. Dept. of Labor, 1970; Droege, 1968
"	10 studies - electronics jobs		X	X	X	various education, training proficiency criteria	median .10	U.S. Dept. of Labor, 1970; Droege, 1968
"	257 studies - industrial jobs		X	X	X	various education, training proficiency criteria	median .25	U.S. Dept. of Labor, 1970; Droege, 1968
"	28 studies - miscellaneous jobs		X	X	X	various education, training proficiency criteria	median .10	U.S. Dept. of Labor, 1970; Droege, 1968
Stromberg Dexterity Test	Israeli high school students	224			X	shop mechanics course grades	.29	Rim, 1962
Hand Tool Dexterity Test	Israeli high school students	224			X	shop mechanics course grades	.32	Rim, 1962
"	gas appliance servicemen	60	X			average job proficiency rating	.29	Laney, 1951
"	gas appliance servicemen	75		X		training grades	.21	Laney, 1951
"	male machine tool operator	66	X			supervisor ratings	.46	Bennett & Fear, 1943
"	female aircraft construction riveters	51	X			supervisor ratings	.51	Test Manual, 1981
"	female assemblers	57	X			supervisor ratings	.14	Test Manual, 1981
"	white maintenance mechanics	187	X			supervisor ratings (3 dimensions)	median .17	Test Manual, 1981
"	minority maintenance mechanics	41	X			supervisor ratings (3 dimensions)	median .10	Test Manual, 1981
"	vocational school trainees	46		X		instructor ratings	.46	Test Manual, 1981
"	electrical maintenance workers	122	X			supervisor ratings	.29	Test Manual, 1981

Construct Manual Dexterity (Continued)

Test	Sample	N	Criterion Type: Job	Trg	Ed	Description of Criterion	Validity Results	Reference
Hand Tool Dexterity Test	automotive maintenance workers	53	X			supervisor ratings	.34	Test Manual, 1981
"	gas appliance service employees	60	X			supervisor ratings	.29	Test Manual, 1981
Pennsylvania Bi-Manual Work Sample	Israeli high school students	224			X	shop mechanics course grades	.10	Rim, 1962
Formboard Test	sewing machine operators	69		X		6 measures of training success	median .00	Farr et al., 1971
"	sewing machine operators	98	X			3 measures of turnover	median .02	Farr et al., 1971
Peg Turning	Air Force pilots	51		X		instructor training course laboratory ratings	.27	Mathews & Jensen, 1977
"	Air Force pilots	38		X		training course grades	-.14	Mathews & Jensen, 1977
Peg Placing	Air Force pilots	51		X		instructor training course laboratory ratings	-.02	Mathews & Jensen, 1977
"	Air Force pilots	38		X		training course grades	-.10	Mathews & Jensen, 1977

Construct Multilimb Coordination

Test	Sample	N	Job	Trg	Ed	Description of Criterion	Validity Results	Reference
Two-Hand Pursuit Test	bombardier trainees	425		X		graduation-elimination from bombardier training	.20	Melton, 1947
"	advanced bombardier trainees	421		X		graduation-elimination from advanced bombardier training	.20	Melton, 1947
"	Army Air Forces pilot trainers in 8 classes	1,169		X		graduation-elimination from training	median .26	Melton, 1947
"	Army Air Forces trained Sperry turret gunners	32	X			gunnery accuracy	.43	Melton, 1947
"	Army Air Forces trained B-29 remote control turret gunners	164	X			gunnery accuracy	.22	Melton, 1947
"	Armed Air Forces trained Martin turret gunners	32	X			circular error in estimating the lead	.43	Melton, 1947
"	Army Air Forces radar operator trainees	381		X		composite of classroom, trainer, and flight grades	.01	Melton, 1947

Construct Multilimb Coordination (Continued)

Test	Sample	N	Criterion Type: Job	Trg	Ed	Description of Criterion	Validity Results	Reference
Two-Hand Coordination Test (Melton, 1947)	Army Air Forces pilot trainees in 23 classes	32,260		X		graduation-elimination from pilot training	median .29	Melton, 1947
"	Air Force pilot trainees	2,010		X		graduation-elimination from pilot training	.32	Craeger, 1957
"	Air Force advanced pilot trainees in 2 classes	3,538		X		graduation-elimination from pilot training	median .24	Leiman & Friedman, 1952
"	Navy pilot trainees in 2 classes	1,334		X		graduation-elimination from pilot training	median .38	Payne et al., 1952
"	aviation cadets	1,016		X		graduation-elimination from pilot training	.27	Zaccaria & Cox, 1952
"	student officers	547		X		graduation-elimination from pilot training	.26	Zaccaria & Cox, 1952
"	Army Air Forces navigator trainees in 2 classes	1,753		X		graduation-elimination from navigator training	median .18	Melton, 1947
"	Army Air Forces bombardier trainees in 8 classes	3,531		X		graduation-elimination from bombardier training	median .22	Melton, 1947
"	Army Air Forces advanced bombardier trainees	423		X		graduation-elimination from bombardier training	.11	Melton, 1947
"	Army Air Forces pilot trainees	311		X		average check ride grade	.21	Melton, 1947
"	Army Air Forces pilot trainees	1,000		X		instructor ratings on 6 pilot training performance measures	median .20	Melton, 1947
"	Army Air Forces advanced pilot trainees	562		X		instructor ratings of flying proficiency	.06	Melton, 1947
"	Army Air Forces advanced pilot trainees in 3 classes	1,193		X		gunnery scores	median .11	Melton, 1947
"	civilian pilot trainees	37		X		3 subjective ratings of flying proficiency	.02	Lane, 1947
"	civilian pilot trainees	37		X		4 hands-on ratings of proficiency	-.09	Lane, 1947
"	Army Air Forces bombardier trainees	574		X		graduation-elimination from training	.11	Melton, 1947

Construct Multilimb Coordination (Continued)

Test	Sample	N	Criterion Type: Job	Criterion Type: Trg	Criterion Type: Ed	Description of Criterion	Validity Results	Reference
Two Hand Coordination Test (Melton, 1947)	Army Air Forces bombardier trainees	574		X		average training course grades	.14	Melton, 1947
"	Army Air Forces bombardier trainees	574		X		bombing accuracy	.03	Melton, 1947
"	Army Air Forces lead bombardier	27	X			percent of "on target" bombs in combat	.04	Melton, 1947
"	Army Air Forces turret gunners	164		X		gunnery accuracy	.07	Melton, 1947
"	Army Air Forces radar operator trainees	52		X		composite flight and ground trainer grades	median .32	Melton, 1947
"	Army gun crew and missile specialists, 9 samples	1,048	X			supervisor ratings of job knowledge, performance, promotability	median .15	Helme & White, 1958
Two-Hand Coordination Test (Sanders et al., 1971)	Air Force pilot trainees	121		X		graduation-elimination from pilot training	.10	McGrevey & Valentine, 1974
"	Air Force pilot trainees	137		X		graduation-elimination from pilot training	.17	Hunter & Thompson, 1978
"	Air Force pilot trainees	1,725		X		graduation-elimination from pilot training	.15	Bordelon & Kantor, 1986
Rudder Control Test	Army Air Forces B-29 turret gunner	164		X		gunner accuracy	.07	Melton, 1947
"	Army Air Forces airman trainees	311		X		average check ride grade	.21	Melton, 1947
"	Army Air Forces pilot trainees in 12 classes	12,178		X		graduation-elimination from pilot training	median .26	Melton, 1947
"	Army helicopter pilot trainees in 2 classes	249		X		graduation-elimination from helicopter pilot training	median .24	Zeidner et al., 1951
"	aviation cadets in pilot training	1,016		X		graduation-elimination from pilot training	.36	Zaccaria & Cox, 1952
"	student officers in pilot training	547		X		graduation-elimination from pilot training	.25	Zaccaria & Cox, 1952
"	Air Force pilot trainees in 2 classes	733		X		graduation-elimination from pilot training	median .36	Fleishman, 1953

Construct Multilimb Coordination (Continued)

Test	Sample	N	Criterion Type: Job	Criterion Type: Trg	Criterion Type: Ed	Description of Criterion	Validity Results	Reference
Rudder Control Test	foreign military pilot trainees in 2 classes	215		X		graduation-elimination from pilot training	median .42	Mullins et al., 1968
"	Air Force pilot trainees in 2 classes	4,311		X		graduation-elimination from pilot training	median .39	Fleishman, 1954
"	Air Force elementary pilot trainees	2,010		X		graduation-elimination from pilot training	.58	Craeger, 1950
"	Air Force advanced pilot trainees in 2 classes	3,358		X		graduation-elimination from jet flying training	median .32	Leiman & Friedman, 1952
"	Navy pilot trainees in 2 classes	1,349		X		graduation-elimination from jet flying training	median .46	Payne et al., 1952
Complex Coordination Test (Sanders et al., 1971)	Navy pilot trainees	294		X		graduation-elimination from pilot training	.18	Bory & Goodman, 1983
"	Air Force officer pilot trainees in 2 classes	213		X		graduation-elimination from pilot training	median .20	McGrevey & Valentine, 1974
"	Air Force pilot trainees	1,725		X		graduation-elimination from pilot training	.11	Bordelon & Kantor, 1986
Bi-Manual Coordination Test	Army Air Forces aviation students in 2 classes	un-known		X		graduation-elimination from elementary pilot training	median .22	Melton, 1947
"	Army Air Forces bombardier students	144		X		graduation-elimination from navigation training	median .10	Melton, 1947
Complex Coordination Test (Melton, 1947)	Army Air Forces elementary pilot trainees in 24 classes	44,618		X		graduation-elimination from pilot training	median .29	Melton, 1947
"	Army Air Forces pilot trainees	311		X		average check ride grade	.13	Melton, 1947
"	Army Air Forces advanced pilot trainees in 4 classes	1,716		X		gunnery training proficiency scores	median .10	Melton, 1947
"	Army Air Forces advanced pilot trainees	685		X		instructor ratings of flying proficiency	.10	Melton, 1947
"	Army Air Forces advanced pilot trainees	562		X		instructor ratings of flying proficiency	.13	Melton, 1947
"	Army Air Forces navigator trainees in 2 classes	1,752		X		graduation-elimination from navigator training	median .20	Melton, 1947
"	Army helicopter pilot trainees in 2 classes	249		X		graduation-elimination from helicopter training	median .25	Zeidner et al., 1958

Construct Multilimb Coordination (Continued)

Test	Sample	N	Criterion Type: Job	Criterion Type: Trg	Criterion Type: Ed	Description of Criterion	Validity Results	Reference
Complex Coordination Test (Melton, 1947)	Army Air Forces bombardier trainees in 9 classes	4,333		X		graduation-elimination from bombardier training	median .26	Melton, 1947
"	Army Air Forces bombardiers	32	X			percent of "on target" bombs in combat	.24	Melton, 1947
"	Army Air Forces radar operator trainees in 2 classes	450		X		composite flight and ground trainer grades	.18	Melton, 1947
"	Army Air Forces B-29 remote control turret gunners	164	X			gunner accuracy	.16	Melton, 1947
"	Army Air Forces elementary pilot trainee	2,010		X		graduation-elimination from elementary pilot training	.35	Craeger, 1957
"	Army Air Forces elementary pilot trainee	1,000		X		instructor ratings on 6 pilot training criteria	median .21	Melton, 1947
"	Air Force advanced pilot trainees in 2 classes	3,538		X		graduation-elimination from single jet engine training	median .23	Leiman & Friedman, 1952
"	Navy pilot trainees in 2 classes	1,345		X		graduation-elimination from pilot training	median .38	Payne et al., 1952
"	aviation cadets in primary pilot training	1,016		X		graduation-elimination from pilot training	.31	Zaccaria & Cox, 1952
"	student officers in primary pilot training	547		X		graduation-elimination from pilot training	.36	Zaccaria & Cox, 1952
"	Air Force pilot trainees in 2 classes	4,311		X		graduation-elimination from pilot training	median .43	Fleishman, 1954
"	foreign pilot trainees	120		X		graduation-elimination from pilot training	.23	Mullins et al., 1968
"	cab drivers	299	X			several archival measures of driving proficiency	median .06	Farr et al., 1971
Target Tracking Test 2	Army Armor officer trainees	95		X		gunnery skills proficiency composite	.51	Smith & Graham, in press

Construct Rate Control

Rate Control	Army Air Forces radar operator trainees	381		X		graduation-elimination from radar operator training	.02	Melton, 1947

Construct Rate Control (Continued)

Test	Sample	N	Criterion Type: Job	Trg	Ed	Description of Criterion	Validity Results	Reference
Single Dimension Pursuit-meter (timer score)	Army Air Forces pilot trainees in 2 classes	836		X		graduation-elimination from pilot training	.13	Melton, 1947
" (work adder score)	Army Air Forces pilot trainees in 2 classes	836		X		graduation-elimination from pilot training	.06	Melton, 1947
Motor Judgment Test	taxi drivers	301	X			several archival proficiency measures	median -.02	Farr et al., 1971
Target Shoot Test	Army Armor officer trainees	95		X		gunnery skills proficiency composite	median .27	Smith & Graham, in press

Construct Speed of Arm Movement

Test	Sample	N	Job	Trg	Ed	Description of Criterion	Validity Results	Reference
Two-Plate Tapping Test	Army Air Forces aviation students	1,194		X		graduation-elimination from pilot training	.07	Melton, 1947

Construct Wrist-Finger Speed

Test	Sample	N	Job	Trg	Ed	Description of Criterion	Validity Results	Reference
GATB - Motor Coordination	97 studies - professional, technical, managerial jobs		X	X	X	various educational, training, and proficiency criteria	median .12	U.S. Dept. of Labor, 1970 Droege, 1968
"	49 studies - clerical jobs		X	X	X	various educational, training, and proficiency criteria	median .14	U.S. Dept. of Labor, 1970 Droege, 1968
"	5 studies - sales jobs		X	X	X	various educational, training, and proficiency criteria	median .14	U.S. Dept. of Labor, 1970 Droege, 1968
"	5 studies - protective service jobs		X	X	X	various educational, training, and proficiency criteria	median .23	U.S. Dept. of Labor, 1970 Droege, 1968
"	47 studies - service jobs		X	X	X	various educational, training, and proficiency criteria	median .20	U.S. Dept. of Labor, 1970 Droege, 1968
"	59 studies - maintenance jobs		X	X	X	various educational, training, and proficiency criteria	median .16	U.S. Dept. of Labor, 1970 Droege, 1968

Construct Wrist-Finger Speed (Continued)

Test	Sample	N	Criterion Type: Job	Trg	Ed	Description of Criterion	Validity Results	Reference
GATB - Motor Coordination	10 studies - electronics jobs		X	X	X	various educational, training, and proficiency criteria	median .14	U.S. Dept. of Labor, 1970 Droege, 1968
"	256 studies - industrial jobs		X	X	X	various educational, training, and proficiency criteria	median .21	U.S. Dept. of Labor, 1970 Droege, 1968
"	28 studies - miscellaneous jobs		X	X	X	various educational, training, and proficiency criteria	median .22	U.S. Dept. of Labor, 1970 Droege, 1968
EAS - Manual Speed and Accuracy	graduating commerce students	70	X			hired/not hired as clerk	.33	Test Manual, 1957
"	female claims processors	35	X			high/low supervisory ratings	.27	Test Manual
"	male students	36			X	machine shop course grades	-.07	Test Manual
"	male students	43			X	engineering drafting class grades	.25	Test Manual
"	electronics technician students	48			X	final course grades	.10	Test Manual
"	electronics technician students	70			X	final course grades	.18	Test Manual
"	electronics technician students	69			X	final course grades	.15	Test Manual
"	electronics technician students	76			X	final course grades	.15	Test Manual
Large Tapping Test	South Vietnamese Air Force pilot trainees	210		X		graduation-elimination from pilot testing	.03	Croll, 1973
Large Tapping Test	Air Force pilot trainees	245		X		graduation-elimination from pilot training	.05	Hunter & Thompson, 1978
Mark Making Test	Air Force pilots	79		X		instructor training course laboratory ratings	.10	Mathews & Jensen, 1977
"	Air Force pilots	62		X		training course grades	-.19	Mathews & Jensen, 1977
Manual Speed	Navy personnel in several ratings	415	X			whether assigned to apprenticeship or technical rating	.14	Cory et al., 1980

Construct Wrist-Finger Speed (Continued)

Test	Sample	N	Criterion Type: Job	Criterion Type: Trg	Criterion Type: Ed	Description of Criterion	Validity Results	Reference
Hand Skills Test	Navy personnel in several ratings	432	X			whether assigned to appren ticeship or technical rating	.20	Cory et al., 1980

NOTES: Trg = Training Criteria
Ed = Education Criteria (e.g., course grades)

APPENDIX C

Reliability Results for Selected Measures of

Nine Psychomotor Constructs

Reliability Results for Selected Measures of Nine Psychomotor Constructs

Construct Aiming

Test	Sample	N	Type of Reliability: Test-Retest	Split-Half	Other	Description of Method	Results	Reference
Trace Tapping II	——	——				——	——	——
Small Tapping Test	unknown	unknown		X		split-half, corrected for full test length	.89	Fleishman & Hempel, 1954
Crossing Test	——	——				——	——	——
Tracing	Air Force ROTC students	203		X		odd-even split-half reliability, corrected for full test length	.85	Fleishman, 1954
Trace Tapping I	——	——				——	——	——
FACT Precision	ninth graders	991			X	correlation between separately timed parts, corrected for full test length	.85	Test Manual, 1959
"	twelfth graders	1,056			X	correlation between separately timed parts, corrected for full test length	.74	Test Manual, 1959
"	twelfth graders	293		X		split-half	.83	Test Manual, 1959
FACT Coordination	ninth graders	991			X	correlation between separately timed parts, corrected for full test length	.85	Test Manual, 1959
"	twelfth graders	1,056			X	correlation between separately timed parts, corrected for full test length	.86	Test Manual, 1959
"	twelfth graders	293		X		split half	.86	Test Manual, 1959
"	college students	50	X			time period unknown	.65	Hinrichs, 1970

Construct Arm Hand Steadiness

Test	Sample	N	Type of Reliability: Test-Retest	Split-Half	Other	Description of Method	Results	Reference
Arm-Hand Steadiness Test	Army Air Forces pilot candidates	310			X	mean correlations between scores on 3 15-second trials using preferred hand, Spearman-Brown corrected	.76	Melton, 1947
"	Army Air Forces aircrew candidates	328	X			1 week	.75	Melton, 1947
"	Army Air Forces aircrew candidates	200		X		odd-even split-half reliability, corrected for full length of test (2 trials)	.90	Melton, 1947
Steadiness Aiming Test	aviation students	461			X	average inter-trial correlation between scores in 6 trials of the test, corrected for full test length	.96	Melton, 1947
"	Air Force ROTC students	203			X	unknown	.84	Parker & Fleishman, 1960
Line Control	—	—				—	—	—

Construct Control Precision

Test	Sample	N	Test-Retest	Split-Half	Other	Description of Method	Results	Reference
Rotary Pursuit Test	basic trainee airmen	204		X		odd-even split-half reliability, corrected for full test length (5 trials)	.81	Fleishman, 1958
"	unclassified candidates for pilot training	398	X			immediate	.88	Melton, 1947
"	unclassified candidates for pilot training	301		X		odd-even split-half reliability, corrected for the full test length (20 trials)	.98	Melton, 1947
Pursuit Confusion Test (Time on Target)	Air Force basic trainee airmen	204		X		odd-even split-half reliability, corrected for full test length	.82	Fleishman, 1958
" (Errors)	Air Force basic trainee airmen	204		X		odd-even split-half reliability, corrected for full test length	.84	Fleishman, 1958
" (Time on Target)	Air Force ROTC students	203			X	unknown	.88	Parker & Fleishman, 1960

Construct Control Precision (Continued)

Test	Sample	N	Type of Reliability: Test-Retest	Split-Half	Other	Description of Method	Results	Reference
Pursuit Confusion Test (Errors)	Air Force ROTC students	203			X	unknown	.90	Parker & Fleishman, 1960
Dial Setting Test	Air Force basic trainee airmen	431		X		odd-even split-half reliability, corrected for full test length (4 trials)	.65	Melton, 1947
"	Air Force basic trainee airmen	204		X		odd-even split-half reliability, corrected for full test length	.80	Fleishman, 1958
Target Tracking Test 1	Army soldiers in various MOSs	254			X	coefficient alpha	.97	McHenry, 1987
"	Army soldiers in various MOSs	113	X			2 weeks	.68	McHenry, 1987
"	Army soldiers in various MOSs	9,251	X			2 weeks	.74	Peterson et al., 1987
"	Army soldiers in various MOSs	9,251		X		odd-even reliability, corrected for full test length	.98	Peterson et al., 1987

Construct Finger Dexterity

Santa Ana Finger Dexterity Test	pilot training candidates	403	X			immediate	.85	Melton, 1947
"	pilot training candidates	314	X			1 week	.74	Melton, 1947
"	pilot training candidates	701	X			28 day	.74	Melton, 1947
"	pilot training candidates	1,000		X		odd-even split-half reliability, corrected for full test length (15 trials)	.93	Melton, 1947
"	basic trainee airmen	200		X		odd-even split-half reliability, corrected for full test length	.91	Fleishman, 1954
Purdue Pegboard	unknown	unknown	X			median 1-trial test-retest, time period(s) unknown	.68	Mental Measurements Yearbook V, p. 903
" (right hand)	college students	434	X			time period unknown	.63	Test Manual, 1948

Construct Finger Dexterity (Continued)

Test	Sample	N	Type of Reliability: Test-Retest	Split-Half	Other	Description of Method	Results	Reference
Purdue Pegboard (left hand)	college students	434	X			time period unknown	.60	Test Manual. 1948
" (both hands)	college students	434	X			time period unknown	.68	Test Manual, 1948
" (assembly)	college students	434	X			time period unknown	.68	Test Manual, 1948
"	male college students	175	X			time period unknown	.71	Test Manual, 1948
"	female radio tube mounter trainees	233	X			time period unknown	.76	Surgent, 1947
"	Air Force ROTC students	203			X	average reliability of 4 test subparts, Spearman-Brown corrected	.90	Parker & Fleishman, 1960
"	male undergraduate and graduate students	130		X		split-half	.87	Comrey, 1953
"	male undergraduates	94		X		split-half	.77	Comrey & Deskin, 1954a
"	female university students	120		X		split-half	.86	Comrey & Deskin, 1954b
O'Connor Finger Dexterity	Air Force ROTC students	203			X	unknown	.76	Parker & Fleishman, 1960
"	unknown	unknown	X			1/2 hour	.82	Test Manual
"	unknown	unknown	X			1 1/2 hours	.89	Test Manual
"	unknown	unknown		X		split-half, Spearman-Brown corrected	.87	Test Manual
"	unknown	unknown		X		split-half, Spearman-Brown corrected	.90	Test Manual
"	basic airmen	100	X			1 1/2 hours	.86	Fleishman, 1953
"	radio mounters	233		X		split-half	.99	Dashfield, 1947
"	unknown	unknown	X			1/2 hour	.89	Blum, 1940
"	unknown	unknown		X		split-half	.90	Darley, 1940

Construct Finger Dexterity (Continued)

Test	Sample	N	Type of Reliability: Test-Retest	Split-Half	Other	Description of Method	Results	Reference
GATB - Finger Dexterity	high school seniors	1,210	X			3 month	.67	U.S. Dept. of Labor, 1970
"	government employees	un-known	X			1 year	.76	U.S. Dept. of Labor, 1970
"	government employees	un-known	X			2 year	.68	U.S. Dept. of Labor, 1970
"	government employees	un-known	X			3 year	.74	U.S. Dept. of Labor, 1970
Crawford Small Parts Dexterity Test (Part 1)	male high school students	93		X		split-half	.80	Test Manual, 1956
" (Part 1)	male high school students	56		X		split-half	.84	Test Manual, 1956
"	male high school students	118		X		split-half	.90	Test Manual, 1956
"	male veterans	66		X		split-half	.91	Test Manual, 1956
" (Part 2)	male veterans	66		X		split-half	.95	Test Manual, 1956
"	male high school students	93		X		split-half	.91	Test Manual, 1956
"	male high school students	56		X		split-half	.90	Test Manual, 1956
"	male high school	118		X		split-half	.94	Test Manual, 1956
" (Part 1)	female applicants for assembly jobs	119			X	internal consistency	.90	Osborne & Sanders, 1956
" (Part 2)	female applicants for assembly jobs	119			X	internal consistency	.89	Osborne & Sanders, 1956
Pinboard Test	—	—				—	—	—

Construct Manual Dexterity

Minnesota Rate of Manipulation Test (Placing)	Air Force ROTC students	203			X	correlation between 2 test trials, corrected by Spearman-Brown formula	.87	Fleishman, 1954

Construct Manual Dexterity (Continued)

Test	Sample	N	Type of Reliability: Test-Retest	Split-Half	Other	Description of Method	Results	Reference
Minnesota Rate of Manipulation Test (Turning)	Air Force ROTC students	203			X	correlation between 2 test trials, corrected by Spearman-Brown formula	.79	Fleishman, 1954
Minnesota Rate of Manipulation Test (Placing)	unknown	212			X	unknown	.87	Test Manual, 1969
" (Turning)	unknown	212			X	unknown	.91	Test Manual, 1969
" (One hand, Turning and Placing)	unknown	212			X	unknown	.95	Test Manual, 1969
" (Two hand, Turning and Placing)	unknown	212			X	unknown	.94	Test Manual, 1969
GATB - Manual Dexterity	high school seniors	1,210	X			3 month	.73	U.S. Dept. of Labor, 1970
"	government employees	un-known	X			1 year	.76	U.S. Dept. of Labor, 1970
"	government emp /ees	un-known	X			2 year	.72	U.S. Dept. of Labor, 1970
"	government employees	un-known	X			3 year	.78	U.S. Dept. of Labor, 1970
Stromberg Dexterity Test	female assembler/welder applicants	70			X	correlation between trials 3 and 4, corrected using Spearman-Brown formula	.84	Test Manual
Hand Tool Dexterity Test	trade school students	80			X	correlation between trials 3 and 4, corrected using Spearman-Brown formula	.87	Test Manual
"	unknown	un-known	X			time period unknown	.91	Test Manual
"	high school dropouts	153	X			1 - 5 days	.81	Test Manual
"	high school students in an aviation mechanics program	75	X			immediate	.88	Test Manual

Construct Manual Dexterity (Continued)

Test	Sample	N	Type of Reliability: Test-Retest	Split-Half	Other	Description of Method	Results	Reference
Pennsylvania Bi-Manual Work Sample	vocational school students	112		X		split-half	.90	Roberts, 1945
Formboard Test	—	—				—	—	—
Peg Turning	—	—				—	—	—
Peg Placing	—	—				—	—	—

Construct Multilimb Coordination

Test	Sample	N	Test-Retest	Split-Half	Other	Description of Method	Results	Reference
Two-Hand Pursuit Test	Air Force basic trainee airmen	204		X		odd-even split-half reliability, corrected for full test length	.83	Fleishman, 1958
"	Army Air Forces aircrew candidates in 8 classes	2,112			X	mean inter-trial correlation among 8 trials, corrected for full test length	median .90	Melton, 1947
Two-Hand Coordination Test (Melton, 1947)	pilot training candidates	416	X			*immediate*	.83	Melton, 1947
"	pilot training candidates	320	X			1 week	.78	Melton, 1947
"	pilot training candidates	700	X			28 day	.87	Melton, 1947
"	pilot training candidates	1,912		X		odd-even split-half reliability, corrected for full test length (8 trials)	.90	Melton, 1947
"	Air Force basic trainee airmen	204		X		odd-even split-half reliability, corrected for full test length (4 trials)	.80	Fleishman, 1958
Two-Hand Coordination Test (Sanders et al., 1971)	Air Force officer trainees	120			X	correlation between minutes 4 and 5 of test, corrected for length of 2 scores	.81	Sanders et al., 1971
Rudder Control Test	airmen trainees	204		X		odd-even split-half, Spearman-Brown corrected for full test length (3 trials)	.82	Fleishman, 1958
"	Army Air Forces pilot training candidates	312	X			28 day	.76	Melton, 1947

Construct Multilimb Coordination (Continued)

Test	Sample	N	Type of Reliability: Test-Retest	Split-Half	Other	Description of Method	Results	Reference
Rudder Control Test	Army Air Forces pilot training candidates	311	X			28 day	.67	Melton, 1947
"	Army Air Forces pilot training candidates	1,000		X		odd-even split-half, corrected for full test length (6 trials)	.93	Melton, 1947
Complex Coordination Test (Sanders et al., 1971)	Air Force officer trainees	120			X	correlation between scores for minutes 4 and 5 of test, corrected for full test length	.92	Sanders et al., 1971
Bi-Manual Coordination Test	Army Air Forces airmen trainees	532		X		odd-even split-half reliability, Spearman-Brown corrected	.95	Melton, 1947
Complex Coordination Test (Melton, 1947)	Air Force basic trainees	204		X		odd-even split-half reliability, Spearman-Brown corrected for full test length	.82	Fleishman, 1958
"	Army Air Forces pilot training candidates	415	X			immediate	.87	Melton, 1947
"	Army Air Forces pilot training candidates	313	X			1 week	.59	Melton, 1947
"	Army Air Forces pilot training candidates	692	X			28 day	.83	Melton, 1947
"	Army Air Forces pilot training candidates	7,627		X		odd-even split-half reliability, corrected for full test length (4 trials)	.89	Melton, 1947
Target Tracking Test 2	Army soldiers in various MOSs	249			X	coefficient alpha	.97	McHenry, 1987
"	Army soldiers in various MOSs	113	X			2 week	.77	McHenry, 1987
"	Army soldiers in various MOSs	9,239	X			2 week	.85	Peterson et al., 1987
"	Army soldiers in various MOSs	9,239		X		odd-even split-half corrected for full test length	.98	Peterson et al., 1987

Construct Rate Control

Test	Sample	N	Type of Reliability: Test-Retest	Split-Half	Other	Description of Method	Results	Reference
Rate Control	airborne radar students	381		X		odd-even split-half reliability, corrected for full test length (8 trials)	.81	Melton, 1947
"	basic trainee airmen	204		X		odd-even split-half reliability, corrected for full test length (4 trials)	.69	Fleishman, 1958
Single Dimension Pursuitmeter	pilot training candidates	1,483		X		odd-even split-half reliability for work adder score, corrected for full test length (8 trials)	.92	Melton, 1947
"	pilot training candidates	1,483		X		odd-even split-half reliability for timer score, corrected for full test length (8 trials)	.88	Melton, 1947
"	basic airmen trainees	204		X		odd-even split-half reliability for timer score, corrected for full test length (4 trials)	.76	Fleishman, 1958
Motor Judgment Test	qualified aircrew candidates	50		X		odd-even split-half reliability for error score, corrected for full test length (8 trials)	.95	Melton, 1947
"	qualified aircrew candidates	50		X		odd-even split-half reliability for revolutions score, corrected for full test length (8 trials)	.92	Melton, 1947
"	basic trainee airmen	204		X		odd-even split-half reliability for ratio of errors to revolutions, corrected for full test length (8 trials)	.76	Fleishman, 1958
"	Air Force ROTC students	203		X		split-half	.56	Parker & Fleishman, 1960
Target Shoot Test	Army soldiers in various MOSs	245			X	coefficient alpha	.85	McHenry, 1987
" (distance)	Army soldiers in various MOSs	102	X			2 week	.56	McHenry, 1987

Construct Rate Control (Continued)

Test	Sample	N	Type of Reliability: Test-Retest	Split-Half	Other	Description of Method	Results	Reference
Target Shoot Test (distance)	Army soldiers in various MOSs	8,892	X			2 week	.37	Peterson et al., 1987
" (distance)	Army soldiers in various MOSs	8,892		X		odd-even reliability, corrected for full test length	.74	Peterson et al., 1987
" (time to fire)	Army soldiers in various MOSs	102	X			2 week	.47	McHenry, 1987
" (time to fire)	Army soldiers in various MOSs	8,892	X			2 week	.58	Peterson et al., 1987
" (time to fire)	Army soldiers in various MOSs	8,892		X		odd-even reliability, corrected for full test length	.85	Peterson et al., 1987

Construct Speed of Arm Movement

Test	Sample	N	Test-Retest	Split-Half	Other	Description of Method	Results	Reference
Two-Plate Tapping Test	candidates for pilot training	500			X	mean correlation test scores for each of the first 3 minutes of the test, corrected for full test length (8 minutes)	.96	Melton, 1947
"	Air Force ROTC students	203			X	unknown	.99	Parker & Fleishman, 1960
"	unclassified airmen candidates	500	X			immediate	.91	Melton, 1947

Construct Wrist-Finger Speed

Test	Sample	N	Test-Retest	Split-Half	Other	Description of Method	Results	Reference
GATB - Motor Coordination	high school seniors	1,210	X			3 month	.82	U.S. Dept. of Labor, 1970
"	government employees	unknown	X			1 year	.86	U.S. Dept. of Labor, 1970
"	government employees	unknown	X			2 year	.85	U.S. Dept. of Labor, 1970
"	government employees	unknown	X			3 year	.88	U.S. Dept. of Labor, 1970

Construct Wrist-Finger Speed (Continued)

Test	Sample	N	Type of Reliability: Test-Retest	Split-Half	Other	Description of Method	Results	Reference
EAS - Manual Speed and Accuracy	various occupations	907	X			2 - 14 days	.75	Test Manual, 1957
"	freshman engineering students	335	X			1 week	.79	Test Manual, 1957
Large Tapping Test	basic trainee airmen	200		X		odd-even split-half reliabilities, corrected for full test length	.94	Fleishman, 1954
Mark Making Test	—	—				—	—	—
Manual Speed	Navy personnel in several ratings	133	X			5 weeks	.57	Cory et al., 1980
Hand Skills Test	Navy personnel in several ratings	172	X			5 weeks	.68	Cory et al., 1980

APPENDIX D

Multi-Trial Means and Standard Deviations for Selected Measures of Nine Psychomotor Constructs

Multi-Trial Means and Standard Deviations for Selected Measures of Nine Psychomotor Constructs

Construct Aiming

Test	Sample	Trial 1	2	3	4	5	6	7	8	Reference
Trace Tapping II	—	—	—	—	—	—	—	—	—	—
Small Tapping Test	—	—	—	—	—	—	—	—	—	—
Crossing Test	—	—	—	—	—	—	—	—	—	—
Tracing	—	—	—	—	—	—	—	—	—	—
Trace Tapping I	—	—	—	—	—	—	—	—	—	—
FACT Precision	—	—	—	—	—	—	—	—	—	—
FACT Coordination	—	—	—	—	—	—	—	—	—	—

Construct Arm Hand Steadiness

Test	Sample	Trial 1	2	3	4	5	6	7	8	Reference
Steadiness Aiming Test	461 aviation students	74.9 (29.5)	71.5 (28.7)	73.9 (28.3)	74.2 (27.9)	75.7 (28.9)	75.2 (29.2)	—	—	Melton, 1947
Line Control	—	—	—	—	—	—	—	—	—	—

Construct Control Precision

Test	Sample	Trial 1	2	3	4	5	6	7	8	Reference
Rotary Pursuit Test	500 pilots	30.03[a] (15.77)	44.26 (19.88)	52.58 (20.79)	—	—	—	—	—	Melton, 1947
Pursuit Confusion Test	—	—	—	—	—	—	—	—	—	—
Dial Setting Test	431 Army Air Forces Airmen candidates	3.04 (.80)	3.51 (.89)	4.00 (.94)	4.07 (.89)	—	—	—	—	Melton, 1947
Target Tracking Test 1	100 Army soldiers in various MOSs	3.18 (.36)	3.15 (.58)	—	—	—	—	—	—	McHenry, 1987

Construct Finger Dexterity

Test	Sample	Trial 1	2	3	4	5	6	7	8	Reference
Santa Ana Finger Dexterity Test	40 aircrew personnel	28.7 (3.99)	33.1 (3.59)	33.9 (3.79)	34.4 (3.80)	35.1 (3.79)	35.4 (3.92)	35.9 (4.01)	36.3 (4.03)	Melton, 1947
Purdue Pegboard	—	—	—	—	—	—	—	—	—	—
O'Connor Finger Dexterity Test	—	—	—	—	—	—	—	—	—	—
GATB - Finger Dexterity	—	—	—	—	—	—	—	—	—	—
Crawford Small Parts Dexterity Test	—	—	—	—	—	—	—	—	—	—

Construct Finger Dexterity (Continued)

Test	Sample	Trial								Reference
		1	2	3	4	5	6	7	8	
Pinboard Test	___	___	___	___	___	___	___	___	___	___

Construct Manual Dexterity

Minnesota Rate of Manipulation Test	___	___	___	___	___	___	___	___	___	___
GATB - Manual Dexterity	___	___	___	___	___	___	___	___	___	___
Stromberg Dexterity Test	___	___	___	___	___	___	___	___	___	___
Hand Tool Dexterity Test	___	___	___	___	___	___	___	___	___	___
Pennsylvania Bi-Manual Work Sample	___	___	___	___	___	___	___	___	___	___
Formboard Test	___	___	___	___	___	___	___	___	___	___
Peg Turning	___	___	___	___	___	___	___	___	___	___
Peg Placing	___	___	___	___	___	___	___	___	___	___

Construct Multilimb Coordination

Test	Sample	Trial 1	2	3	4	5	6	7	8	Reference
Two-Hand Pursuit Test	—	—	—	—	—	—	—	—	—	—
Two-Hand Coordination Test (Sanders et al., 1971)	—	—	—	—	—	—	—	—	—	—
Two-Hand Coordination Test (Melton, 1947)	—	45.74 (13.11)	51.43 (13.82)	57.40 (13.57)	55.01 (13.41)	58.09 (13.27)	59.42 (13.57)	63.81 (12.75)	60.23 (14.25)	Melton, 1947
Rudder Control Test	1797 aviation students	193.4 (47.8)	211.4 (34.2)	225.1 (26.6)	223.9 (23.7)	229.8 (19.6)	229.4 (18.0)	—	—	Melton, 1947
Complex Coordination Test (Sanders et al., 1971)	—	—	—	—	—	—	—	—	—	—
Bi-Manual Coordination Test	—	—	—	—	—	—	—	—	—	—
Complex Coordination Test	500 Army Air Forces pilots	7.90 (2.65)	10.51 (2.60)	11.83 (2.64)	12.25 (2.70)	12.77 (2.80)				Melton, 1947
Target Tracking Test 2	—	3.89 (.47)	3.95 (.60)	—	—	—	—	—	—	McHenry, 1987

Construct Rate Control

Rate Control	—	—	—	—	—	—	—	—	—	—

Construct Rate Control (Continued)

Test	Sample	Trial 1	2	3	4	5	6	7	8	Reference
Single Dimension Pursuitmeter	—	—	—	—	—	—	—	—	—	—
Motor Judgment Test	—	—	—	—	—	—	—	—	—	—
Target Shoot Test	100 Army soldiers in various MOSs	9.64 (7.51)	10.05 (10.87)	—	—	—	—	—	—	McHenry, 1987

Construct Speed of Arm Movement

Test	Sample	Trial 1	2	3	4	5	6	7	8	Reference
Two-Plate Tapping Test (* 1 minute of work)	500 unclassified airmen candidates	297.7[b] (37.1)	286.0 (35.9)	278.5 (35.5)	266.8 (35.0)	257.8 (33.8)	252.1 (33.5)	249.0 (32.9)	249.0 (32.8)	Melton, 1947

Construct Wrist-Finger Speed

Test	Sample	Trial 1	2	3	4	5	6	7	8	Reference
GATB - Motor Coordination	—	—	—	—	—	—	—	—	—	—
EAS - Manual Speed and Accuracy	—	—	—	—	—	—	—	—	—	—
Large Tapping Test	—	—	—	—	—	—	—	—	—	—
Manual Speed	—	—	—	—	—	—	—	—	—	—

Construct Wrist-Finger Speed (Continued)

Test	Sample	Trial 1	2	3	4	5	6	7	8	Reference
Hand Skills Test	—	—	—	—	—	—	—	—	—	—
Mark Making	—	—	—	—	—	—	—	—	—	—

[a] five trials

[b] one minute of work

APPENDIX E

Correlations Between Measures of Nine Psychomotor Constructs and Various Cognitive Abilities

Correlations Between Measures of Nine Psychomotor Constructs and Various Cognitive Abilities

Construct Aiming

Psychomotor Test	N	Cognitive Ability: Perceptual Speed and Accuracy	Spatial Ability	Mechanical Aptitude	Verbal Ability	Numerical Aptitude	Reasoning	Science Knowledge	Electronics Knowledge	Auto/Shop Tool Knowledge	Reference
Trace Tapping II	—	—	—	—	—	—	—	—	—	—	—
Small Tapping Test	—	—	—	—	—	—	—	—	—	—	—
Crossing Test	—	—	—	—	—	—	—	—	—	—	—
Tracing	—	—	—	—	—	—	—	—	—	—	—
Trace Tapping I	—	—	—	—	—	—	—	—	—	—	—
FACT Precision	1,056	.35	.23	.18	.25	.27	.27	—	—	—	Test Manual, 1959
"	1,563	.30	.19	.08	.21	.17	.15	—	—	—	Test Manual, 1959
FACT - Coordination	1,056	.21	.07	.06	.12 .22	.14	.14	—	—	—	Test Manual, 1959
"	1,563	.31	.30	.13	.16	.20	.16	—	—	—	Test Manual, 1959

Construct Arm-Hand Steadiness

Psychomotor Test	N	Perceptual Speed and Accuracy	Spatial Ability	Mechanical Aptitude	Verbal Ability	Numerical Aptitude	Reasoning	Science Knowledge	Electronics Knowledge	Auto/Shop Tool Knowledge	Reference
Arm-Hand Steadiness Test	1,520	.06	.04	.00	.01	.01	-.01	—	—	—	Melton, 1947
Steadiness Aiming Test	—	—	—	—	—	—	—	—	—	—	—
Line Control	—	—	—	—	—	—	—	—	—	—	—

Construct Control Precision

Psychomotor Test	N	Perceptual Speed and Accuracy	Spatial Ability	Mechanical Aptitude	Verbal Ability	Numerical Aptitude	Reasoning	Science Knowledge	Electronics Knowledge	Auto/Shop Tool Knowledge	Reference
Rotary Pursuit Test	1,096	.15	.16	.25	.10	.06	—	—	—	—	Melton, 1947
"	3,000	.12	.13	.20	.08	.03	—	—	—	—	Melton, 1947
"	1,500	—	.12	.26	.05	.01	—	—	—	—	Melton, 1947
"	1,930	—	.15	.21	.03	.00	—	—	—	—	Melton, 1947
"	5,000	.15	.13	.23	.06	.04	.06	—	—	—	Melton, 1947

Construct Control Precision (Continued)

Psychomotor Test	N	Cognitive Ability: Perceptual Speed and Accuracy	Spatial Ability	Mechanical Aptitude	Verbal Ability	Numerical Aptitude	Reasoning	Science Knowledge	Electronics Knowledge	Auto/Shop Tool Knowledge	Reference
Rotary Pursuit Test	un-known	—	.13	.15	.00	.01	.03	—	.11	—	Fleishman, 1954
Pursuit Confusion Test	—	—	—	—	—	—	—	—	—	—	—
Dial Setting Test	150	.22	.08	-.06	.14						Melton, 1947
Target Tracking Test 1	212	.06	—	.41	.18	.23	.33	.25	.29	.35	McHenry, 1987

Construct Finger Dexterity

Psychomotor Test	N	Perceptual Speed and Accuracy	Spatial Ability	Mechanical Aptitude	Verbal Ability	Numerical Aptitude	Reasoning	Science Knowledge	Electronics Knowledge	Auto/Shop Tool Knowledge	Reference
Santa Ana Finger Dexterity Test	5,000	.19	.16	.09	.11	.16	.09	—	—	—	Melton, 1947
"	1,096	.15	.13	.11	.07	.11	—	—	—	—	Melton, 1947
"	3,000	.16	.12	.08	.04	.08	—	—	—	—	Melton, 1947
"	1,520	.10	.12	.07	.05	.07	.06	—	—	—	Melton, 1947
"	1,930	—	.16	.04	.04	.03	—	—	—	—	Melton, 1947
"	un-known	.27	—	.20	.26	—	—	—	—	.15	Fleishman & Hempel, 1955
Purdue Pegboard	un-known	.36	—	.19	.24	—	—	—	—	.46	Fleishman & Hempel, 1955
O'Connor Finger Dexterity	75	—	-.16	-.11	—	—	.21	—	—	—	Lancy, 1951
GATB - Finger Dexterity	23,428	.32	.29	—	.17	.24	.25	—	—	—	U.S. Dept. of Labor, 1970
"	168	.27	.32	.27	.15	.20	.18	—	—	—	U.S. Dept. of Labor, 1970
"	565	.19	.17	—	.11	.12	.13	—	—	—	U.S. Dept. of Labor, 1970
Crawford Small Parts Dexterity Test	430	—	—	.27	.06	.14	.21	—	—	—	Grant & Bray, 1970
"	119	—	—	—	.15	.20	—	—	—	—	Osborne & Sanders, 1956

Construct Finger Dexterity (Continued)

Psychomotor Test	N	Cognitive Ability: Perceptual Speed and Accuracy	Spatial Ability	Mechanical Aptitude	Verbal Ability	Numerical Aptitude	Reasoning	Science Knowledge	Electronics Knowledge	Auto/Shop Tool Knowledge	Reference
Pinboard Test	—	—	—	—	—	—	—	—	—	—	—

Construct Manual Dexterity

Psychomotor Test	N	Perceptual Speed and Accuracy	Spatial Ability	Mechanical Aptitude	Verbal Ability	Numerical Aptitude	Reasoning	Science Knowledge	Electronics Knowledge	Auto/Shop Tool Knowledge	Reference
Minnesota Rate of Manipulation Test	—	—	—	—	—	—	—	—	—	—	—
GATB - Manual Dexterity Scale	23,428	.26	.21	—	.10	.21	.19	—	—	—	U.S. Dept. of Labor, 1970
"	168	.37	.16	.16	.06	.13	.03	—	—	—	U.S. Dept. of Labor, 1952
"	565	.31	.18	—	.10	.12	.08	—	—	—	U.S. Dept. of Labor, 1952
Stromberg Dexterity Test	—	—	—	—	—	—	—	—	—	—	—
Hand-Tool Dexterity Test	60	—	.25	.13	—	.00	-.02	—	—	—	Lancy, 1951
Pennsylvania Bi-Manual Work Sample	—	—	—	—	—	—	—	—	—	—	—
Formboard Test	—	—	—	—	—	—	—	—	—	—	—
Peg Turning	—	—	—	—	—	—	—	—	—	—	—
Peg Placing	—	—	—	—	—	—	—	—	—	—	—

Construct Multilimb Coordination

Psychomotor Test	N	Perceptual Speed and Accuracy	Spatial Ability	Mechanical Aptitude	Verbal Ability	Numerical Aptitude	Reasoning	Science Knowledge	Electronics Knowledge	Auto/Shop Tool Knowledge	Reference
Two-Hand Pursuit Test	—	—	—	—	—	—	—	—	—	—	—
Two-Hand Coordination Test (Melton, 1947)	5,000	.15	.18	.33	.09	.06	.19	—	—	—	Melton, 1947
"	1,096	.15	.20	.40	.17	.05	—	—	—	—	Melton, 1947
"	3,000	.14	.15	.41	.21	.01	—	—	—	—	Melton, 1947
"	1,520	.09	.13	.27	.11	.04	.09	—	—	—	Melton, 1947

Construct Multilimb Coordination (Continued)

Psychomotor Test	N	Cognitive Ability: Perceptual Speed and Accuracy	Spatial Ability	Mechanical Aptitude	Verbal Ability	Numerical Aptitude	Reasoning	Science Knowledge	Electronics Knowledge	Auto/Shop Tool Knowledge	Reference
Two-Hand Coordination Test (Melton, 1947)	1,500	—	.17	.41	.06	.09	—	—	—	—	Melton, 1947
"	1,930	—	.14	.35	.05	.05	—	—	—	—	Melton, 1947
Two-Hand Coordination Test (Sanders et al., 1971)	120	—	—	-.15	.07	-.06	—	-.12	—	—	Sanders et al., 1971

Construct Multilimb Coordination (Continued)

Rudder Control Test	5,000	.06	.10	.35	.03	-.06	.07	—	—	—	Melton, 1947
"	1,500	—	.14	.27	.01	.00	—	—	—	—	Melton, 1947
"	1,930	—	.05	.27	-.01	-.04	—	—	—	—	Melton, 1947
"	un-known	—	.07	.20	-.03	-.12	.05	—	.13	—	Fleishman, 1954
Complex Coordination Test (Sanders et al., 1971)	120	—	—	-.10	-.02	.06	—	.05	—	—	Sanders et al., 1971
Bi-Manual Coordination Test	un-known	.21	.14	.00	.03	.02	—	—	—	—	Melton, 1947
Complex Coordination Test (Melton, 1947)	1,096	.19	.27	.32	.17	.14	—	—	—	—	Melton, 1947
"	3,000	.21	.25	.31	.19	.08	—	—	—	—	Melton, 1947
"	1,520	.16	.23	.24	.16	.11	.15	—	—	—	Melton, 1947
"	1,500	—	.25	.36	.15	.11	—	—	—	—	Melton, 1947
"	1,930	—	.26	.29	.16	.14	—	—	—	—	Melton, 1947
"	200	—	.26	.31	.12	.10	.18	-	.18	—	Fleishman, 1954
"	un-known	.39	—	.46	.23	—	—	—	—	.33	Fleishman & Hempel, 1955
"	5,000	.27	.29	.34	.18	.16	.19	—	—	—	Melton, 1947
Target Tracking Test 2	212	.01	—	.39	.16	.24	.30	.29	.31	.38	McHenry, 1987

Construct Rate Control

		Cognitive Ability									
Psychomotor Test	N	Perceptual Speed and Accuracy	Spatial Ability	Mechanical Aptitude	Verbal Ability	Numerical Aptitude	Reasoning	Science Knowledge	Electronics Knowledge	Auto/Shop Tool Knowledge	Reference
Rate Control	—	—	—	—	—	—	—	—	—	—	—
Single Dimension Pursuit-meter	—	—	—	—	—	—	—	—	—	—	—
Motor Judgment Test	—	—	—	—		—	—	—	—	—	—
Target Shoot Test	212	.02	—	.22	.04	.12	.17	.13	.18	.20	McHenry, 1987

Construct Speed of Arm Movement

Two-Plate Tapping Test	—	—	—	—	—	—	—	—	—	—	—

Construct Wrist-Finger Speed

GATB - Motor Coordination	23,428	.51	.20	—	.37	.41	.36	—	—	—	U.S. Dept. of Labor, 1970
"	565	.46	.14	—	.32	.27	.24	—	—	—	U.S. Dept. of Labor, 1970
EAS - Manual Speed and Accuracy	—	—	—	—	—	—	—	—	—	—	—
Large Tapping Test	305	—	.02	.14	.11	—	.10	—	.14	.09	Hunter, 1975
Mark Making Test	—	—	—	—	—	—	—	—	—	—	—
Manual Speed	—	—	—	—	—	—	—	—	—	—	—
Hand Skills Test	—	—	—	—	—	—	—	—	—	—	—